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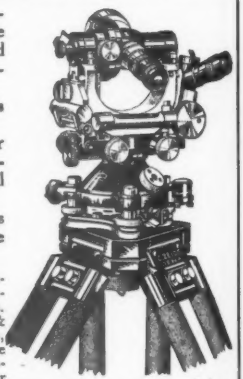

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The GEOGRAPHICAL JOURNAL

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THE ALAI-PAMIRS IN 1913 AND 1928: *A paper read at the Evening Meeting of the Society, 29 April 1929, by*

W. RICKMER RICKMERS

THE term Alai-Pamirs covers the mountainous regions between the Amu Darya, the Sir Darya and the Chinese border. Hence it applies to the Pamir block and its westerly fringes. In accordance with political frontiers one might also speak of the Russian Pamirs.

Besides having acquired a definite morphological meaning (a pamir=a valley of the Pamir type), the Pamir has become very elastic in a topographical sense, not to speak of the plural which appears to be of English origin. Khargush Pamir, Alichur Pamir are divisions of the whole (that part of the Pamir called Hare Pamir) like West London or South London. The Londons would therefore correspond to the Pamirs. We observe a transition from place-name to general term. It reminds me of a Russian peasant who once asked me: "Is your Volga as big as ours?"

Comparing the map in W. Geiger's book ('Die Pamirgebiete') published in 1887 with "The Pamirs" of the Survey of India (Sheet 42) reprinted with corrections in 1922, one is at once struck by their similarity. What one may call the small-scale features of the Pamirs (including the Alai and Bukhara) have undergone practically no change during the last forty years. Thus, apart from the more exact determination of heights and astronomical positions, the map of the Pamirs is now one for filling in detail. It may therefore be taken as an example of the step from extensive to intensive cartography.

The old Russian survey of 10 versts to the inch (1 : 420,000) has served as the foundation or framework for every subsequent map of the Pamirs. As time went on more or less sketchy improvements were added in irregular patches. Without exception this new topography had to do with inaccessible mountains, inaccessible that is to say from the military surveyor's point of view, for he had to work with a certain rapidity in order to finish the map of Russia's newly acquired possessions in Turkistan. Eating his way through the cake he struck hard objects in the shape of clusters or chains of peaks, glaciers, and gorges. Even had he been a member of the Alpine Club he could not have wasted time on these lumps of last resistance, for army and administration wanted to know as quickly as possible about all the places where war could be

waged and taxes levied. By a process of natural elimination the glacier districts were left over for the mountain explorer.

Considering its age, purpose, and speed of publication the old Russian map is really very good. Plains, rivers, villages, roads, and passes are shown with reasonable exactitude. In other words, the map is reliable where a horseman can travel. We have the arterial system of the rivers and everything it entails in the way of life, settlement, and trade. Hence the map nowhere shows considerable tracts of totally unexplored country. To make up for this, nearly the whole of the mountain skeleton between the river ramifications is, so to speak, imaginary. The unexplored orography is dovetailed into the known hydrography, so that for a re-survey of the mountains the whole ground has to be gone over again.

The filling in of mountain detail by Russian, British, French, and German travellers has never ceased during the last forty years. Yet such is the wealth of this detail that even the revised sheets of the 10-verst map still convey the same general impression. Unfortunately, it is difficult to distinguish fact from fancy because the old surveyor was possessed by a horror of the void. His aesthetic sense apparently revolted against white patches. These he peopled with contorted caterpillars created partly from hearsay, partly from his inner consciousness. A few larger areas, however, he tinged a lighter yellow, notably around the headwaters of the Bartang, Yazgulam, Vanch, and Khingab, on both sides of the Muk Su, and in Qarategin north of the Surkhab. These then are the big "white patches" of the Alai-Pamirs.

Let it be understood that I hold the Russian surveyor and traveller in high esteem. Knowing absolutely nothing about mountaineering, Mushketov in 1880 crossed the Macha pass at the head of the long and difficult Zarafshan glacier. In 1904 Korjenevski fought his way through the dangerous gorge of the Muk Su. I only mention these two out of innumerable feats generally accomplished with poor equipment and very little money.

This not being the place for a long history and bibliography, I may be allowed to lead up to 1913 and 1928 with my own work as illustrating the progress of mountain exploration in Russian Turkistan. After my first visit to Bukhara in 1894 I gradually moved eastward, attracted by the cream-coloured patches of Eastern Bukhara and the Western Pamirs mentioned above. An unwieldy and forgotten volume gives the condensed results of my wanderings up to 1912 ('The Duab of Turkestan': Cambridge University Press, 1913).

The two expeditions which form the subject of this paper are separated by fifteen years, but connected by the same fundamental idea, namely the exact survey of certain mountains. During the interval very little happened in a region which, in my innermost heart, I had reserved for myself. On the other hand, something had happened which allowed me to visit the Pamirs which a former government had closed to foreigners since Filchner's military speculations.

In 1913, when I led the expedition of the German and Austrian Alpine Association, the late Dr. Deimler made a photogrammetric survey of part of Qarategin and more especially of the Range of Peter the Great. After Dr. Deimler's early death Dr. von Gruber prepared two maps from the negatives,

Morainic landscape of Tupcheq

Moraine shelf of Little Tupcheq: on left Baizirek valley, eroded later

one showing the Barolmas and Qizil Su glaciers in great detail on a scale of 1 : 50,000 (*Zeitschr. für Gletscherkunde*, xiv, 1926). The other is a "Kammkarte," *i.e.* a ridge-map of Qarategin on which the lower valleys are not shown (*Zeitschr. d. Ges. f. Erdkunde*, 1925).

In 1928 Dr. R. Finsterwalder surveyed about 4000 square miles of mountains and glaciers between the Sel Tau, Trans-Alai, and Zulum Art ranges and the Tanimas river. The completion by stereoautograph will, of course, take some time. I think I may predict a great stride in automatic cartography. It would be unfair to compare Deimler's and Finsterwalder's maps on the lines of merit. In 1913 photogrammetric surveying was still in its infancy. According to present-day standards Deimler's quarter-plate apparatus was fairly primitive. Moreover he had to work single-handed. Finsterwalder and his assistant Biersack used a set of the most modern half-plate photo-theodolites by Zeiss. Deimler was a climbing mathematician who had taken up surveying for this particular trip ; Finsterwalder is a highly trained specialist.

Notwithstanding the gulf of time the expedition of 1928 is the immediate continuation of that of 1913 inasmuch as both together are the first attempt to produce a complete and satisfactory map of considerable mountain areas in the Alai-Pamirs. Side by side we see here an illustration of the great stride made in photo-surveying: and we learn that sometimes one does gain by waiting. Photo-surveying would enable a score of topographers to revise the whole of the map of the Alai-Pamirs within five years.

The expedition of 1913 was financed and entrusted to my care by the German and Austrian Alpine Association. Besides myself the official staff consisted of the late Dr. W. Deimler (topographer) and Dr. (now Professor) R. v. Klebelsberg (geologist). The latter had then already begun to specialize in glacier work. Five members came at their own expense: Dr. H. v. Ficker, now head of the Prussian Meteorological Service ; Dr. A. Kaltenbach as physician and zoologist; Frau Kaltenbach, Mrs. Rickmers, and Herr E. Kuhlmann. The size of this personally conducted party of eight caused some misgivings in geographical circles, but I stuck to my optimism justified by former experiences. The secret is a very simple one. As Gordon MacCreagh ('White Waters and Black') so truthfully says, the leader should not march in front but alongside of his companions. Since then the three Mount Everest Expeditions have provided a brilliant demonstration of this principle.

A brain-wave made me try an unsuccessful experiment. For a scientific observer, I said to myself, walking is better than riding, and donkeys are hardier than horses. So we started out from Samarqand on foot, the baggage being carried by fifty donkeys. But these animals developed sore backs at an alarming rate. Worse still, they were stopped by the deeper fords. Bridges being rare, the rivers are usually forded, and the depth of a manageable ford is measured by the height of a horse. Hence donkey caravans only travel along certain trade-routes with shallow fords. One must remember that for more than a thousand years everything pertaining to travel, including the mentality of camp servants, has followed the horse-standard. Yet I firmly believe that a walking observer will find and note down many new things overlooked by dozens of travellers who passed that way on horseback. My ideal would be a

Moraine shelf of Little Tupcheq : on left Baizirek valley, eroded later

"handy" horse carrying collecting kit, cameras, etc., easily accessible without unloading; or, still better, a couple of porters. A "ferry-camel" for carrying valuables across the more dangerous fords would also be welcome. I have learnt something new about camels, by the way. The fine Bactrians of the Qara-Qirghiz will go almost anywhere in difficult mountain country. After a week I sold the donkeys and we took to horses generously provided by the Amir of Bukhara at the expense of his subjects.

The journey lasted from 2 May to 13 December 1913, and cost £1350. From Samarqand we travelled by the Manis pass (1850 m.) across the Kemkutan mountains, a granite spur of the Hissar range, to Kitab in the valley of the Kashka Darya. Thence to Yakkabagh—Chakman Kuidi pass (2700 m.)—Tashqurghan—Langar-i-Mardan pass (3380 m.)—Sariasia—Qaratagh—Dushambe—Faizabad (1200 m.)—Ab-i-Garm (1400 m.)—Vakhsh river—Muj-i-Kharv (1300 m.)—Garm in Qarategin (1400 m.)—Kala-i-Laleh Ab (1600 m.)—Kanishbeg (1800 m.)—Tupcheq (3300 m.)—Gardan-i-Kaftar pass (3890 m.)—Langar in the Khingab valley (2200 m.)—Pashimgar (2750 m.)—Garmo glacier (to 4000 m.) and back—Aqbai Sitargi pass (4660 m.)—Sitargi on the Vanch (2340 m.)—Kala-i-Rokhar (1880 m.)—along the Panj to Kurgovad (1630 m.)—Aqbai Viskharvi (4160 m.)—Sangvar—Saghir Dasht (3000 m.)—Sariab pass (3600 m.)—Ravnau (2300 m.)—Ravnau pass into Ab-i-Nab valley—Deh-i-Baland (2000 m.)—Langar (1300 m.)—Qashbandon pass (2500 m.)—Muminabad (1200 m.)—Kuliab (600 m.)—Island of Urta Tugai in the Amu Darya—Qurghan Töbe—Kabadian—Baba Tagh—Yangi Bazar in the Surkhan valley—Mirshadi—Baisun—Gusar—Karshi—Bukhara.

Ficker and Klebelsberg took another route home: Khingab—Tabidara (1730 m.)—Talbar pass (2700 m.)—Khovaling (1490 m.)—Baljuan (970 m.)—Faizabad (1200 m.)—Dushambe (930 m.)—Kala in the Varzab valley (1100 m.)—Sigdi (2010 m.)—Shutur Gardan pass across the Hissar range (3555 m.)—Takfan (1820 m.)—Laudan pass (3675 m.)—Kshtut (1400 m.)—Panjkent—Samarqand. To this itinerary must be added a great number of side excursions, glacier explorations and mountain climbs. We ascended about thirty peaks, the highest being 5700 m. As we climbed for topographical and geological purposes only, we had no time to waste on the highest and most difficult mountains.

I shall now briefly refer to the main results and various points of interest. Of Deimler's maps I have already spoken. Klebelsberg wrote 'Beitrage zur Geologie Westturkestans' (Innsbruck, 1922, 480 pp.). The Vienna Academy of Science published Ficker's 'Untersuchungen über die Meteorologischen Verhältnisse der Pamirgebiete' (Wien, 1919).

Klebelsberg's most brilliant discovery is perhaps that of the great Vakhsh fault marked by hot springs (Ab-i-Garm, 40° C.) and frequent earthquakes (destruction of Qaratagh in 1907). From the writings of Mushketov and others it is possible to pick up the continuation of this fault along the Alai valley and the Kashgarian Qizil Su. Extending from the Hissar province to the Tarim basin the Vakhsh fault coincides with the valleys marking the orographical boundary-line between the mountain systems of the Alai and the Pamirs.

Upper Qarategin presents a number of old land surfaces, notably that of

Mountains on left bank of Khingab above Kala-i-Lodzhirk

Looking into Garmo and Bokhud valleys, Darvaz

Tupcheq (Qara Shura), which is at the same time associated with moraines of various ages. The grandest of the old surfaces is that of Darvaz (Saghir Dasht and surroundings).

The snow-line rises from about 4000 m. in Qarategin to about 5000 m. in the Garmo valley, following as usual the elevation of the central mountain mass. To this may be added the increasing distance from the western sources of precipitation. The difference between the north and south faces is enormous, amounting to not less than 1000 m. In September I climbed Mirza Tash (5300 m.) on dry rock from the south. On the top a parapet of snow 4 feet high proved to be the upper edge of a precipitous ice-slope falling away thousands of feet to the Gando glacier on the north side.

It is as yet too early for linking the stages of glaciation with those of the Alps. One of the farthest advances is marked by the fine landscape of terminal moraines left by the old Muk Su glacier (Fedchenko glacier) at the junction of the Muk Su with the Qizil Su. Witnesses to the most recent retreat are the dirty and rubbish-laden lower reaches of dead ice often extending upwards for miles before the white or live glacier is reached. These black snouts seem to point to some comparatively sudden change in which the shortness of the glaciers may have acted as a contributory cause. The longest glacier of the range of Peter the Great does not exceed 12 miles. Many considerable ice-streams such as the Barolmas have neither upper snow basins nor lateral feeders, but depend for their subsistence entirely upon ice-avalanches from the steep walls of corries at their head. Altogether the Alai-Pamirs form a glaciological laboratory which owing to its accessibility facilitates and, owing to climatic contrasts, deserves continuous systematic observation. As an island surrounded by deserts this mountain region forms a splendid object of comparison with the Alps. Here one can apply to new surroundings the knowledge acquired in the Alps during more than a century. On the other hand Turkistan, owing to the dryness of the climate, and the lucidity of the processes of denudation or accumulation, may throw fresh light on the history of Alpine glaciation.

I cherish the fond belief that the solution of the riddle of the dead cities of Chinese Turkistan is to be sought among the Pamir glaciers. Nothing seems to warrant the assumption that the Tarim basin was a zone of rainfall cultivation in historical times. If the change of climate responsible for glacial periods also produced more rain in Central Asia, then it must have been before the advent of historic man, or, to be exact, before the immigration of peasants. The dead cities lived on agriculture by irrigation which drew its water from rivers partly fed by residual ice, by dead ice not replenished from precipitation above the snow-line. This store of ice left over after the last glacial retreat, or cessation of surplus feeding, gradually dwindled. The rivers decreased in volume and after a time were unable to fill the irrigation canals of outlying districts. In that case the problem of the (historic) desiccation of Inner Asia would be changed from one of rainfall to one of residual melting. Thus we should be able to detach this narrower problem from the wider one of climatic change, which looms beyond. We are at once struck by the fact that the stoppage of supplies from the atmosphere must have been more rapid than the melting of old stores. This would point to a comparatively

Looking into Garmo and Bokhud valleys, Darvaz

sudden change of climate. But then everything is or appears sudden in Central Asia. It is a country where every difference is magnified into glaring contrast. The dead glaciers of to-day furnish an example on a smaller scale, although here earthquakes may often be a cause of irregular feeding by shaking the heavy breast-plates of ice from the towering precipices of the upper corries.

From Tashqurghan at the foot of the Sang Gardak mountains Mirza Akhram, the secretary of the Beg of Yakkabagh, led us to the cave Kala-i-Shiran in the limestone canyon of the Kala Sai torrent. The floor of the picturesque gorge is covered with thick jungle where hoary junipers mingle with the slender birch. From a round hole high up in the red-encrusted cliff bursts a powerful jet of water. The two porticoes of the cave open out on the right bank at a height of about 2400 m. above sea-level. The familiarity of our guides with the locality, the remains of torches, and broken stalactites showed that the place is used for pilgrimages or tamashas. Legend calls it Tamerlane's horse-stable, which seems justified by the thick layer of droppings, although these come from the less romantic sheep. Digging a hole we came upon layers of broken bones, and in a cranny we found a very old clay lamp. One of the caverns—its continuation runs into the main cave after a short distance—is neatly walled up with alternate layers of blocks and wooden beams ("gallic" wall). Earth filled in behind makes a wide platform. We went in about 500 yards through halls alternating with narrow passages. In one of these worm-holes I had to crawl flat on my belly. It makes one feel buried alive. The fat Aksakal of Tashqurghan stuck and had to be pulled out by his feet. I refrained from excavations on a large scale for fear of spoiling the work of future experts. Kala-i-Shiran certainly promises well, for its human record must stretch unbroken far into the dim past, although it remains doubtful whether neolithic man ever roamed in this neighbourhood. But cave animals there may have been.

Another little-known place I visited was the island of Urta Tugai formed by two arms of the Oxus south of Kuliab. It was a wonderful paradise of jungle, reed swamps, water runnels, steppe, and sandy stretches, swarming with pheasants, wild pigs, stags (Bukhara type), and tigers. Here I should have liked to roam in the crisp October air, but the unconcealed impatience and contempt of the mathematician drove me from the land of happy play after I had slain only a big tusker. At Kokul just beyond the lower end of Urta Tugai there was a permanent ferry to the Afghan bank.

The climate of the Alai-Pamirs is on the whole as simple as it is dry, though complicated by local vagaries which still require close investigation. The traveller delights in long spells of fine and steadfast weather which does away with much uncertainty in the planning of mountain excursions. To make up for this, visibility is often impaired or entirely suppressed by yellow dust-fogs due to loess carried upwards by currents of hot air. The finer the weather the thicker the mist.

To the temptations of nomenclature we only yielded within forgivable limits. Explorers being poor men, or young men, or both, how can they show their gratitude to helpers of the financial or professorial world better than by writing their names on the map? Our most pressing want seemed to be a

uniform designation of the whole of the range from Mount Sandal (Altin Mazar) to the mouth of the Khingab. Peter the Great already being represented by the western half, we considered the imperial house of Romanov appropriate to the whole. The eastern portion is sometimes called Periokh Tau on older maps, being a corruption of Pir Yakh Tau (peak-snow-mountain, or range of the snowy peaks). Since then the wheel of history has caused the demands of topography to be supplied from other sources, but here as in Canada the bad habit has apparently come to stay—I mean the habit of turning mountains into monoliths in memory of the living.

Is it then so difficult to invent names with local colour? Nobody ever suspects nowadays that Mirza Tash, the "Stone of the Scribe," was invented by me in honour of the official who accompanied me as representative of the Amir. Scholars versed in Persian or Turki or the old Indian dialects of Canada should be able to turn out pithy or poetical names by the hundred.

Our easternmost point was 10 miles up the Garmo glacier, where Dr. Deimler and I were turned back by bad weather late in September; bad weather always means difficulties with porters. From the top of Mirza Tash, which rises above the right bank of the glacier, I obtained a wonderful view of the central Sel Tau and its western branches. Here, then, was my dreamland of the future. And this future more than justified its name, for it lasted fifteen years.

When from a large party in 1913 I blossomed forth into a still larger one in 1928 the step was accepted almost as a matter of course. The era of collective travel by land had established itself in the natural course of events, and the Mount Everest expeditions had restored public confidence shaken by earlier failures.

Consisting of eleven Germans and eleven Russians, the Alai Expedition of 1928 was not only a very large one, but also characterized by the close collaboration of two peoples. This latter feature also has come to stay. Nations on whose territory there is something to investigate no longer care to appear as the passive object of foreign scientists. To begin with, it might be thought that they were incapable of describing their own country. Furthermore, they do not see why their antiquities or ethnographical rarities should be the booty of museums abroad. And finally, a tradition lingering in the popular mind places every explorer into a country peopled by savages. Nobody wishes to exclude helpful neighbours, but everywhere self-esteem has begun to formulate this condition: There shall be no foreign exploration by others without our own active share as homeland explorers.

On sea voyages big scientific staffs have long been customary, for the ship at once suggests a floating university. But on land a geographical levy in mass was rarely attempted with success. Yet one may well ask why Jenghiz Khan and Alexander the Great were able to push vast armies into Europe and India. It seems however that military undertakings belong to another plane of comparison, nothing being easier than to raise money for war, whereas the ventures of trade or science are usually dependent upon private enterprise. Generals have unlimited means and unlimited powers. Military discipline cannot be enforced in exploration because a really capable specialist

will always be an independent thinker and worker. It is therefore easier to manage five thousand soldiers than five scholars.

On the vast expanse of desert or steppe the motor car enables us to mimic sea traffic on land. One feels tempted to elaborate the obvious analogy between a fleet of desert-cars and a fleet of polar vessels.

Apart from these considerations the modern exploring party shows the inevitable evolution from the journey of discovery to the journey of study or committee of investigation. The preliminary survey of the field is followed by an inventory of every detail. Discoverers hunt better alone or in couples, their wide spaces calling for a corresponding liberty of movement. Whatever he may have been besides, say a geologist or botanist, the older traveller had always to be a route-surveyor. His foremost duty was the map, for without a map his work in other directions, however good, remained unscientific in the geographical sense. Geography is the science of map-making and of coordinating all knowledge with the map. In those times it was enough to be a topographer, for mountains, forests, man, and animals were so new that one had only to look at them with open eyes and describe them with a vivid pen.

To-day the world is discovered, that is to say known everywhere in outline. Bold sketching no longer helps; the mosaic between the contours has to be filled in. The finder is being replaced by the examiner, the prospector by the sinker of shafts, the eye by the instrument, the story-teller by the measurer and statistician. The Earth is shrinking, and peoples begin to discover each other instead of waiting for that ridiculous man from Berlin, London, or Harvard. And of the more primitive tribes there are hardly any left who do not expect to be explored at more or less regular intervals, while a few hidden away in dark corners take it for granted that they will soon be discovered.

All human activity moves from extensive to intensive cultivation or organization. The nomad becomes a peasant, the peasant a gardener. But as movement cannot be dissociated from life, nor travelling from exploration, the new order of things has been brought about by a division of labour. Geographical exploration is split up into pure travel and pure study. The leader becomes a travel specialist with an understanding of the needs of each science. At home he builds up an institute. This he lifts bodily through space, setting it down in the distant playground. His companions do not travel there, but are transported. They are let loose on the plot to be cultivated, each starting on his own career of adventure and discovery. Yet all remain united by a central organization, for it is the duty of the leader to relieve his scientific collaborators of the routine of travel. Not theirs to ask how to move, what to eat, or where to sleep. Horse, food, and bed await them at the appointed place and time.

As in all big modern factories, so here, greater capital expenditure must be compensated by quicker results within a given time. The old explorer often stayed away for years; a year may be taken as the minimum. The Russo-German Alai Expedition lasted six and a half months, only five of which were devoted to actual work on the spot. In spite of this the scientific results will fill the usual volume of a thousand pages.

And now one will understand why I have nothing sensational to report.

There simply had to be no adventures if our task was to be done thoroughly and in time. Formerly discoverers went out in search of adventure, for they opened up new ways across oceans and continents, and an unknown road always means adventure. Now adventure has been driven from the high-roads to the lanes and by-paths. For the modern leader any adventure worth talking about means an engineering accident or a flaw in the organization. If thus he foregoes the full measure of popularity which is the reward of mighty deeds, he should remember that it was the heroism of his countless predecessors which made a science of travel possible.

A sympathetic public will have to change its mental attitude towards explorers, if in future it wishes to do them justice, for the adventure of accidents is gradually being transformed into the adventure of organization, almost of high finance. Instead of the sensational fight with unexpected obstacles there is the noiseless war with detail, with equipment, tactics, and accounts. Only the final result of the undertaking becomes visible. For ever invisible remain the sensations surging in the breast of the leader.

The sponsors of the Alai Expedition (1928) were the Notgemeinschaft der Deutschen Wissenschaft in Berlin and the U.S.S.R. Academy of Sciences in Leningrad. The costs were shared by the Soviet and German sides. Elsewhere I have enumerated the long list of those to whom thanks are due. Let me here concentrate my gratitude upon our chief representatives, upon His Excellency Dr. Schmidt-Ott, President of the German Society in Aid of Science, and our Russian leader, Nikolai Petrovich Gorbunov, Chief of the Executive of the Soviet of Peoples' Commissaries. As the third participant in the honours and expenses I must mention the German and Austrian Alpine Association, which contributed four excellent mountaineers. This is not the place for a complete list of our staff and their functions. I shall mention names as occasion offers. During August climbing visitors from Moscow brought our party up to thirty. There never was any grousing or sulking to interfere with work, but only the usual relief of overpressure through the safety-valve of a few well-chosen words. And Russian hospitality was as wonderful as ever. I do not mean sumptuous dinners—those days are past—but the eager interest taken in visitors, and the wish to be helpful.

The official name of the expedition is now the Alai-Pamir Expedition. During its inception it had however been decided to camouflage it as the Alai Expedition. Its main objective, the Sel Tau, was ruled out as being too little known. We did not like to mention the Pamirs, fearing to arouse suspicion, for the Pamirs are like three mighty hands clasped in a grip of steel, each holding on for dear life, yet each hoping that the others might let go. Now that all is over, one realizes that the schemers of dark plots would not have taken a dozen foreigners into their confidence, least of all map-makers. All the same the governor of Kashgar concentrated troops on the border, and many Qirghiz fled into Chinese territory when they heard of our coming.

Early in 1927 I was ordered to start on the somewhat appalling task of getting the equipment ready. How this is done can best be gathered from the three Mount Everest volumes, so that I need not repeat history. But I may

be permitted to dwell upon a hobby of mine which is The Permanent Equipment Shop, "shop" here to be taken in the sense of modelshop and workshop. The science of equipment lacks centralization, so that each traveller or expedition is forced to build up a new organization. It is easy enough to assemble the theory from books, catalogues, and experts, but one misses the rooms where the tradition of tangible things is continued unbroken. To begin with, it is difficult to rent comfortable and business-like quarters for so short a time. I have vivid recollections of odd corners in draughty warehouses, of basements kindly lent, and other localities which one must often be ready to leave at a moment's notice.

What I want is a spacious well-lighted hall which can be made reasonably warm in cold weather. On the floor are painted the ground plans of various tents, boats, wagons, trucks, and cabins, their sections being repeated on the walls. There is a stuffed horse, a camel, a sheep, a porter for trying on loads. Scales big and small will not be forgotten, nor a shaking machine for testing packs. There are work benches and tools of every description for the amateur mechanic, together with an ever-increasing collection of materials (wood, metal, paper, glass, celluloid, textiles, etc.) in their various shapes (flat, long, hollow, etc.). It is most important that one should be able to see, handle, and compare all the possible stuffs from which a thing can be made. There is a representative collection of articles of outfit, models, and dummies, especially receptacles, boxes, and bottles. Next door is the shed for packing and storing. The garden offers space for experimental camping, as well as for playing with fire, mild explosives, pungent chemicals or big noises. All this is in permanent charge of a handy man, a many-sided amateur mechanic. An office contains every facility for correspondence, drawing, and filing. There is a library, while card-indexes furnish classified information on every possible subject connected with equipment: sizes, measurements, carrying capacities, the physical properties of materials (waterproof, insulating, absorbent, soft, elastic, etc.). An Honorary Equipment Secretary surveys the whole. Here at last the art of equipping is brought into line with the scientific management of a modern navy yard or brewery. One can afford a high fee for the use of these rooms, say 10 per cent. of the sum ear-marked for outfit. Why, one would save three times as much in the shape of money otherwise wasted on ballast or useless transport.

There is always the choice between the extremes of a large luxurious outfit and a small Spartan kit. The former is easier to buy, but causes endless trouble and disgust unless one has a special store-keeper (in this case myself). The frugal furnishings require very much more thought at home, but make for a care-free life on the road. There are no lists to keep, as nearly every article is in daily use. When a traveller feels overburdened, there is only one remedy, namely jettison. I was able to save my surplus stores owing to a permanent caravan hired for five months. This was rendered necessary by the constant shifting of base-camps and the frequent redistribution of our skirmishing groups. When we were not actually marching the horses went to and fro between dumps.

The modern travelling scientific institute has to be provided for regardless of weight, for to ensure success within a given time there must never be the

shortest delay due to the temporary want of food, spare parts, or refills. As in scientific industrial management, the proportion between time and work done is a question of money. Other conditions being equal the quick but more expensive management of bulk comes cheaper in the end than piecemeal haulage. The Alai Expedition with its 30 Europeans, 40 servants, 180 horses, and 70 camels accomplished within six months what would have been the task of many years for smaller units. It meant, of course, that the leader had to do all the housekeeping of the expedition, and nothing else. Even then I might have found my hands too full had not Professor Shcherbakov taken many a burden upon himself.

Two large boxes of medical stores have been left at Tashkent for future use, for we had only three surgical accidents and no sickness worth speaking of. As I started my companions on quinine in Leningrad, we had not a single case of malaria. The drawing of teeth was a relaxation which I reserved for my own moments of leisure.

As regards presents one should distinguish between friendly free gifts and presents instead of money. Worldwide trade has by now educated the savage of the story-books who gave food or valuable things in return for rusty pocket-knives or cheap trinkets. Asia with its ancient trade-routes is the last place for speculating in presents. The simplest and in the end cheapest plan is to pay with money or with the standard trade goods, which are but another form of currency. I carried two horse-loads of silver equal to ten camels in the guise of universal providers. Special services or liberal hospitality were rewarded by excellent tools, razors, scissors, hunting knives all of stainless steel, field-glasses, and good jewellery.

In 1928 I wanted to continue where I had left off in 1913. To begin with, I must find out what had been done in the meantime. Fortunately the core of my "reservation"—the central Sel Tau—remained untouched, although the great wave of Russian exploration had thrown a few ripples into the outer bights. In 1917 Byelyaev visited the Garmo glacier and used up the wood which I had dumped on the ice. This pile consisted of trees gathered from a dead forest of juniper lower down on the right bank (change of local climate owing to advance of glacier?). I had hoped that in later years these logs would enable me to estimate the rate of glacier movement. Korjenevski continued his exploration of the Muk Su and also penetrated to the snout of the lowest glacier in the Tanimas valley. Right glad was I to see that Sir Aurel Stein had skirted my ground in 1915—a close shave for me indeed (*G.J.*, 48, 3, 211 ff.). His article forms an excellent introduction to my report. By referring the reader to his descriptions and photographs I save myself much repetition. Arved Schultz's new book ('Landeskundliche Forschungen im Pamir,' Hamburg, 1916) provided me with an up-to-date compendium.

I have brought home a big trunk full of recent Russian literature on Turkistan. The government has taken up exploration as a national matter to be financed by the state. The Academy has a standing committee for organizing expeditions. Last year they sent out between one hundred and two hundred expeditions (I forget the exact number). Most of them are of course small, numbering only one, two, or three men. With funds that to us appear

ridiculously inadequate they face the sands of Qara Qum and the icy swamps of Siberia. I admire these Russian travellers in comparison with whom we are lamentable sybarites.

The main task was a map of as large an area of the Sel Tau as possible (Finsterwalder, Byelyaev, Dorofeev, Issakov, Biersack) overlaid by geological (Nöth) and meteorological (Zimmermann) observations. Around this solid centre was to be grouped the work of the linguist (Lentz), zoologists (Reichardt, Sokolov, Reinig), botanist (Gorbunov), and many other specialists in highly technical branches (geomagnetism, radiology, etc.). Professor Korjenevsky, to our great regret, had to turn back in the Alai valley owing to a weak heart. The well-known company Mejrabpomruss was represented by Messrs. Shneiderov and Tolchan, who produced a very fine film. Herr Wien took charge of the radio for time-signals.

The craving for a few special plums of adventurous discovery was to be satisfied by the crossing of mysterious passes and the ascent of the highest peak. The biggest discovery however, that of the inordinate length of the Fedchenko glacier, came as a complete surprise. The leader, the topographers, and the geologist were necessarily mountaineers. They were supported by a force of crack climbers (Borchers, Allwein, Wien, Kohlhaupt, Schneider) for reconnoitring.

On the Russian 10-verst map (1 : 420,000) the curiosity of the traveller is attracted by the words "Foot Pass" or "Former Pass" written across the crests of several high ranges. Upon inquiry the natives always answer, "O, Tura, our great-grandfathers have used this pass, but it has long ago become impassable owing to the ice." An increase of ice (covering easy slopes) or a retreat of the glacier (exposing steep rocks) is variously given as an explanation. In 1913, however, Professor von Ficker succeeded in finding and crossing one of these mysterious highways, the Sagran, which connects the head of a left tributary of the Muk Su with the Sagran river. At the village of Pashimgar the Sagran flows into the Garmo torrent, which from this point onward is known as the Khingab. Ficker had to feel his way towards the pass as none of the Muk Su Tajiks were willing to give information. Only when he had reached the low saddle separating two easy glaciers did his porters reluctantly admit that this was a well-known and much-used pass. To men on foot it offers no difficulties whatever, and one might at a pinch be able to get horses across. The secrecy surrounding such an easy pass showing traces of constant use can only be explained by the wish of the Tajiks (Galchas) to hide it from the Qirghiz, so that it can always be used for flight or for fetching reinforcements.

The old Aryan population of Darvaz sits astride the boundary ranges so that on the northern slopes of the mountains of Peter the Great (Qarategin) and on the eastern slopes of the Sel Tau (Pamirs) the Tajik are dovetailed into the Qirghiz. This zone of contact means a state of silent war between the two races, each trying to extend its pastures or fields. It is not a war between two nations as a whole, but a state of economic pressure giving rise to small local adjustments where families grow or dwindle. Here and there one finds groups of stone hovels representing relinquished outposts of the Galchas

Snout of Sildi glacier, Tupcheq

Kala-i-Shiran cave

Looking towards Mount Kaufmann from Tenghiz Bai Pass

driven back by the Qirghiz. It is not so easy to see where the nomads have retreated as they leave no permanent buildings behind. Real battles on a large scale do not seem to take place, at least not since the Russian conquest of Turkistan. Curiously enough the two even mix quite readily in some localities. They share the wide pastures of Tupcheq, while in Qarategin on the banks of the Surkhab we find villages where Tajik and Qirghiz till the soil in perfect harmony. Here the nomads prove that they are perfectly capable of settling on the land. The Qirghiz of Qarategin are excellent agriculturists. They are far more intelligent and progressive than the Tajiks. At the University of Tashkent they enjoy the reputation of being good mathematicians.

If the Sagran was merely kept secret, the higher passes across the central Sel Tau, notably the Kashal Ayak, were really abandoned long ago. Being fairly easy for hardy mountaineers, although very long and strenuous, they have not been closed by the forces of nature, but have become obsolete for historical reasons. When the Russians came into the country they did away with small boundaries, welding tribes and minor states into one whole of law and order. Short cuts or loopholes for fugitives, spies, and smugglers became unnecessary. I believe, however, that the Tajiks still use them in a small way and that their memory, notably that of the Kashal Ayak, is kept bright for future emergencies. Dr. Kohlhaupt found the droppings of horses near the second glacier of the Tanimas. We picked up an old corn-pestle below the Notgemeinschaft glacier, and near Dust Camp discovered a hunters' lair with a wind-screen, cinders, and ibex horns. All this would show that the upper Tanimas valley has never been quite deserted. Besides hunters and shepherds, prospectors for gold must be counted among its regular visitors. Indeed, our very presence may have been responsible for its look of utter desolation, a sort of camouflage by abstention.

In this connection I may mention that the route Pamirs—Zulum Art pass—Baland Kiik valley—Kaindi pass—Altin Mazar—Daraut Qurghan is still being used by smugglers from Chinese Turkistan. The frontier guards who accompanied us made a big haul of over a hundred sheep that were being driven down the Baland Kiik from Kashgar. The Russians do not seem to keep a very strict watch on the Pamir boundary, but to rely upon catching the contraband nearer its point of destination. The smugglers on the other hand must have great confidence in the secret sympathy of the population. This route may well have been an alternative to the old trade route from Eastern to Western Turkistan, for one can take camels along during the autumn months. But as it is bound to join the main road at Daraut Qurghan, there being absolutely no other way out from Altin Mazar, this alternative can only have been of use to avoid dangers lurking in the Alai valley between the Chinese frontier and Daraut Qurghan.

In my plans for an attack upon the central Sel Tau I had to consider two approaches, from the west and from the east. In this choice I was guided by the size of the party, by the wish to start work as early as possible in the season, and by the advantages of one central base-camp for all operations. The roads through the steep and narrow western valleys are more difficult for large caravans than the flat Pamirs. On this side which faces the sources

Looking towards Mount Kaufmann from Tenghiz Bai Pass

of precipitation the wet spring weather lasts longer than on the Pamirs, which are practically rainless. A glance at the map, furthermore, shows three big valleys descending from the western flanks of the Sel Tau range, namely the valleys of the Khingab, the Vanch, and the Yazgulam, whose high dividing ridges mean difficult lateral communications along the great mountain chain. Towards the Pamirs there is only one big valley, that of the Tanimas or upper Bartang. Now when one valley does the work of three opposite ones one may surmise that its branches join the heads of the three counterparts, thus giving access to the same length of main range. Hence one base-camp would do for three. This strategical theory proved itself correct although in quite an unexpected manner. In reality it is not the Tanimas river but the Fedchenko glacier which, as a drainage system, corresponds to the western valleys. We hoped to discover an enormous Tanimas glacier, instead of which we found a dry valley which only serves as an overflow to the Fedchenko during high glacial tides.

The only difficulty on the eastern side, and that a serious one, is the question of supplies. Apart from the Alai valley, where numerous rich Qirghiz pasture their flocks, our way from Osh to the base-camp was practically through uninhabited desert. Late in June the few inhabitants of the Alai mountains north of the Taldik pass had already left for the higher ground. From Bordoba to Tanimas past the Great Qara Köl and Kokjar we did not see more than about a dozen yurts or families. This also meant scarcity of fodder and fuel, for the number of Qirghiz is on the whole proportionate to the grazing surface. And scarcity of cattle means scarcity of dung for the kitchen fire. Teresken (wormwood), the only other fuel, is nowhere plentiful along the usual tracks or around the camping-grounds. Hence when one has a large caravan, decency forbids camping longer than one night on the green spots barely sufficient for the flocks of the nomads. In between these places our horses found next to nothing to supplement their barley rations. These conditions forced us to accumulate a big dump of flour, barley, and wood (archa, *i.e.* juniper) at the ruined rabat (rest-house) of Tukur Bai on the eastern shore of the Great Qara Köl. These stores were brought thither by camel caravan from Osh, the wood being picked up in the juniper forests of Oltin Lug on the north side of the Taldik pass. Here we also concentrated close upon three hundred sheep, most of which came from the Alichur Pamir, where they were more numerous and much cheaper. After the establishment of the base-camp our horses were kept busy fetching supplies from Tukur Bai.

To this must be added the difficulty of obtaining porters for transport on the higher mountains and glaciers. We drafted these men from the upper villages on the Bartang, 30 and 40 miles away. The distance made recruiting still more difficult, as it had to be done through emissaries. Moreover, these Tajiks (mountain Tajiks or Galchas) are a very unenterprising race, and during summer their minds are wholly occupied with their wretched barley crops. One cannot even tempt them by an offer to buy their poor harvest outright.

All this made the base-camp in the Tanimas valley very expensive. But it was then the only possible take-off for a frontal attack upon the long line of the Sel Tau. The head of the Khingab valley would have been far more agreeable. There one lives in the midst of a large population, while supplies

Looking from Dust Camp to narrows formed by dead ice snout of Notgemeinschaft glacier

Glacier II, Tanimas: alluvial cone from side gulley blocking main valley

Terraced shelf, Kanidi valley

Glaciers on south side of Tanimas valley below pass

Pinnacles on Glacier III, Tanimas

Sand-dunes in Tanimas valley above Notgemeinsch[illegible]

can easily be obtained from Qarategin. Beautiful jungle grows right up to the snout of the Garmo glacier. But after that one lands in a cul-de-sac. To-day we know that the best base is Altin Mazar, whence the Fedchenko glacier forms a high-road from north to south. But then, who could have dreamt that the best base for exploring a long range was at its very end? Altin Mazar is only five days from Marghilan by easy roads, whereas it takes at least a fortnight from Osh to Tanimas across the Pamirs.

Not wishing to repeat myself, I must refer the reader to the preliminary report of the German Society in Aid of Science (Deutsche Forschung, 'Aus der Arbeit der Notgemeinschaft der Deutschen Wissenschaft,' Heft 8, "Die Alai-Pamir Expedition 1928," Berlin, 1929, 196 pp.). Here I shall only give a compressed itinerary and a mere abstract of results.

Main Line

Osh (left June 19)—Gulcha—Qizil Qurghan—Sufi Qurghan—Qizil Beles pass—Taldik pass—Saritash—Bordoba—Qizil Art pass—Kok Sai (Markan Su)—Tukur Bai (4000 m., July 2 to 8)—Ju Ui (Muz Qol river)—Lake Quruq Köl—Qirghiz camp Qara Chim (about 4200 m.) below Qizil Beles (about 4400 m.)—Kokjar—Urus Tugai (Sea Buckthorn Camp) on the lower Tanimas (3200 m.)—Dust Camp above snout of Notgemeinschaft glacier (3500 m.)—Tanimas pass (4400 m.)—back to Kokjar (September 10)—Takhta Qorum pass—Kaindi pass—Altin Mazar—Ters Agar pass—Daraut Qurghan—Tengiz Bai pass (3400 m.)—Qaraul (1100 m.)—Uch Qurghan Aravan—Osh (October 21).

Branch Lines

From the Great Qara Köl to a camp in the Qara Jilga valley and thence exploration of the glaciers on the south side of the Trans-Alai, partly with the object of finding a way up Pik Kaufmann (renamed by the Russians Pik Lenin).

From Dust Camp to nearly all the glaciers of the central Sel Tau. Ascent of many peaks. Then down the Fedchenko glacier to Altin Mazar.

Across the Kashal Ayak pass and back (Borchers and Wien). Long stay at Oroshor on the upper Bartang for ethnographical purposes (Dr. Lentz). Lentz and Kohlhaupt afterwards travelled to Qarategin across Darvaz and the Gardan-i-Kaftar pass. Lentz finally went home by way of Dushambe.

Daraut Qurghan—Katta Qaramuk—Achik Alma—Jailgan in the morainic landscape between Muk Su and Qizil Su. Ascents in the unexplored mountains between the two rivers. Back to Daraut Qurghan.

Great Qara Köl—Aq Baital—Shor Köl—Rang Köl—Aqsu—Pamirski Post—Yaman Tal—Naiza Tash—Alichur Pamir—Kumdi pass—Zor Köl—Pamir Darya—Madz pass—Shakh Dara—Turumtai Köl—Koitesek pass—Bulun Köl—Yashil Köl—Langar Davan pass—Sarez Köl (landslide lake)—Nusur on the Bartang—Kokjar (September 12). This is the route of our zoologist Dr. Reinig.

Bartang—Khorjin pass—Yazgulam pass—Fedchenko glacier (Gorbunov and party).

Rang Köl (Gorbunov and party).

Dr. Nöth, our geologist, traversed the ground in all directions. Professor Korjenevski explored glaciers on the north side of the Trans-Alai near

Sand-dunes in Tanimas valley above Notgemeinschaft

Pinnacles on Glacier III, Tanimas

Bordoba (Burtope Mazar). Allwein, Wien, and Schneider ascended Pik Lenin (7130 m.) on September 25. This summary of itineraries does not claim completeness in every detail, but will be enough to give an idea of the work done.

Dr. Finsterwalder, assisted by Herr Biersack and T. G. Dorofeev, photographed from 130 standpoints, measured various base-lines, and made a series of triangulations. A number of astronomical points were determined by Professor Byelyaev of Pulkovo, who also helped with the triangulations and other exact measurements. Finsterwalder brought home 600 half-plate negatives, all of which came out well. From his material he promises us the following maps: A stereoautographic map 1 : 50,000 covering 400 square miles of the Fedchenko and Tanimas glacier systems, almost without a single gap. Then a "ridge" map showing 6000 square miles of the Sel Tau, Trans-Alai, and Western Pamirs. In this the amount of detail will vary considerably. A few special maps, such as that of the lower Notgemeinschaft glacier, will supply glaciological data and enable us to judge future changes. A set of repeated photographs from the same standpoint makes it possible to compute the present rate of movement of some of the glaciers.

Dr. Nöth thinks that the folding up of the Alai-Pamirs began at the end of the Palaeozoic epoch, probably between the Carboniferous and Permian periods. Then all the ranges rose simultaneously. During the Jurassic period the region was partly covered by sea, with the exception of the northern portion which was probably lifted. This conclusion is derived from the continental character of the Jurassic sediments of the Trans-Alai. The Cretaceous sea encroached still farther, so that the Alai channel probably connected the Cretaceous basin of Bukhara with that of Tibet. The sediments of the inner Pamirs however retain their continental character. During the early Tertiary period we may assume the first upheavals along the Alai synclinal, judging from the enormous conglomerates of early Tertiary origin. In mid-Tertiary times mountain uplift was at its height. There was folding of the Mesozoic and early Tertiary strata of the Alai valley and an over-thrust of the Pamirian chains. The sea finally withdrew, leaving the region to the processes of denudation and accumulation. Dr. Nöth furthermore emphasizes the fact that the general strike of the folds runs east–west. A north–south strike is nowhere continued for long. Hence north–south ranges such as the Sel Tau are not tectonic ranges. Along the western flank of the Sel Tau runs a considerable fault which forces the glaciers to descend in gigantic ice-falls 1000 feet and more in height. Round the Great Qara Köl there is remarkable good evidence of three tiers of old land surfaces at about 4100, 4250, and 4450 metres above sea-level. All the glaciers are in retreat with the exception of a small tributary of the Tanimas.

The results of my Russian collaborators are not yet to hand. N. P. Gorbunov specialized in economic botany, and also attempted the artificial fertilization of ewes of the fat-tailed sheep from freshly killed rams of the Pamir sheep (*Ovis poli*). Dr. Zimmermann's meteorological observations should throw much light upon the climate of the Pamirs. After setting up observatories at Saritash and Tukur Bai, which were run by his assistants for three months, he accompanied us to Dust Camp and the Tanimas pass. The study of this weather-divide is important for glaciology. Messrs. Tabulski and Brimann

conducted radiotechnical investigations, while Mikhalkov devoted himself to geomagnetism. Shcherbakov and Labuntsov studied the minerals, Reichardt and Sokolov made large zoological collections. Nor should I forget our visitors who spent their holidays with us in order to do some mountaineering. They were Professor Schmidt, President of the Statistical Office, Public Prosecutor Krilenko, Mrs. Rozmirovich, and Dr. Rossels, a well-known surgeon. They helped in reconnoitring the glaciers and made the first crossing of the Yazgulam pass.

Dr. Reinig, the German zoologist, was not so much seeking new species as a rich harvest of facts concerning three biological questions : variation according to locality ; conditions of local races (biotopes) ; vertical distribution. In the Pamirs, as in all mountainous countries, high natural boundaries favour the development of local races. This can best be seen by paying attention to animals with a known tendency towards variation. Reinig therefore carefully tracked down bumble-bees (*Bombus*) and the big beetles of the genus *Carabus*. In the Central Pamirs bumble-bees are found nesting as high as 4800 m., although the soil is permanently frozen. The nests are therefore quite close to the surface warmed by the sun.

Dr. Lentz penetrated deeply into the mysteries of the Pamir dialects spoken by the mountain Tajiks or Galchas of Shugnan, Rushan, etc. These languages belong to the East Iranian branch. It is high time that science took stock of them, for they are in danger of being swamped by New Persian, Russian, or some nondescript caravan language. The political and economic opening up of the high valleys is making great strides, so that the original traits of national life and character will soon be blurred. Dr. Lentz was surprised by the wealth of oral literature in verse and prose which he found in the miserable villages of the Bartang. He has brought home a great collection of texts together with phonographic and musical records. His scientific report will show a great step forward in our knowledge of an ancient people.

Among the more conspicuous objects of Tajik handicraft are the woollen stockings and the ceremonial veils or chashband. The many-hued stockings on which the svastica often recurs remind one of Fair Isle work. The women go unveiled but wear a beautifully embroidered face-curtain for the marriage ceremony. The outstanding ornamental symbol is that of the red cock. Some of these chashbands are hundreds of years old.

Marco Polo's sheep are not yet threatened by extinction, and in some places are even plentiful. Vast stretches of the Pamirs are so thinly populated that even modern weapons in the hands of the natives do not mean a wholesale destruction of game. Nor can the dangerous occasional sportsman (official, trader, soldier) travel very far afield owing to the difficulty of obtaining food or shelter. Roughly the boundary between *Ovis poli* and ibex coincides with the geographical boundary between the Pamirs proper and the marginal or alpine ranges (central and peripheral districts). Polo's sheep prefer the vast undulations of sloping hills rising thousands of feet above the flat bottoms of the Pamirs. Ibex prefer rocky ridges. The sheep can climb very well but do not care to do so as a rule, probably owing to their great size and weight. Kokjar is one of the places where the habitats of the two meet, as can be seen from the horns lying on the ground. But whereas the sheep strictly

confine themselves to the Pamirs, the ibex penetrate into the interior wherever jagged crests and pinnacles offer them suitable conditions. Thus we find them on the southern peninsula of the Great Qara Köl among the blistered rocks of a mountain desert which might just as well be in the Sahara 12,000 feet lower down. Ibex are prone to form local varieties. The horns of the Sauk Dara seemed to me to be bent in a narrower circle than those from other valleys. Various valleys of the western ranges simply swarm with these noble animals, so that one often meets herds of a hundred head and more. During several days at tea-time I was able to watch a small herd from Dust Camp, feeding on a high ridge. The Qirghiz told me that at Kokjar, besides sheep and ibex, one finds markhor and a "goat with small, short horns."

The traveller who scans the mountain side for a likely camping-ground with shelter and fuel is quick to notice the presence or absence of the juniper tree, which is the most familiar boundary-post between the inner and outer climate. The Pamirs are quite treeless, with the exception of a few famous clumps of willows. The juniper also strictly avoids all the slopes and valleys facing the Pamirs as for instance the south side of the Alai range. But as soon as one has crossed the Taldik or Tengiz Bai northward bound, the slopes resume their characteristic spotted appearance. There is no juniper in the Tanimas valley, but plenty of it in the Kaindi valley. Below Daraut Qurghan the mountains on the left bank of the Qizil Su (facing north) are thickly sprinkled with juniper while those on the right bank remain bare. The difference between the inner and outer Pamirs is here carried on, as it were, for some time longer by the contrast between north and south exposure. Still farther west the juniper does not show quite so marked a preference for the s. ady side.

As to the orographical and glacial features of our field of exploration, I was struck by many curious facts which to my great regret I was unable to examine systematically, my time being taken up by general staff work. I did not climb more than a few insignificant hills, the highest of which was 5500 m.

The most prominent curiosity is, of course, the Fedchenko glacier stretching for 40 miles along the eastern flank of the Sel Tau chain. Its embryonic bed was probably sketched out by a fault which need not have been very big as long as it was continuous, a small crack being sufficient to guide erosion. This fault may correspond to the one running along the western declivity. The climatic watershed of the Sel Tau did the rest. It absorbs nearly the whole of the precipitation coming from the west. The whole of the rainfall need not necessarily be caught by the side turned towards the area of evaporation. On the contrary, only after passing the crest, the clouds, now thoroughly cooled, will be ready to shed the larger portion of their load. But they do seem to shed it very quickly, as is shown by the astonishingly low rainfall of the Pamirs, 62 mm. or barely 2 inches yearly. From Dust Camp I often saw bad weather on the Tanimas pass, but the clouds never passed me on their way eastwards. Nearing the meridian of Dust Camp they dissolved, leaving a blue sky above me. Bad weather on the Pamirs such as I met during my ride from the Great Qara Köl to Kokjar at the beginning of July consisted of short, sharp showers lasting five or ten minutes. It was "bad weather with little rain." To the question "What is the Fedchenko glacier?" one may therefore answer, "It is the snow which has not reached the Pamirs."

In a general way the glaciers of the Sel Tau are longer and more alpine in character than those of the range of Peter the Great, although their ends also show the usual snout of dead ice covered with rubble. But this dead ice is less honeycombed than that of the Garmo or Zarafshan glaciers. The front of the Notgemeinschaft glacier forms an enormous fan-shaped landscape of high ice-cones hidden under blocks precariously balanced, but with only a few of those deep funnels with lakes at their bottoms so typical of the Garmo or Zarafshan. On the other hand, the Sel Tau glaciers boast of white-ice pinnacles the like of which I had never seen before in Turkistan, the white ice of the western glaciers being comparatively smooth. Towards the lower ends of the long glaciers these pinnacles often reach a height of 50 or 60 feet. They are arranged in rows corresponding to the junctions of tributary glaciers, so that their origin may partly be due to greater density owing to pressure, and partly to protection by medial moraine. The sun chiselled these ridges into shapes which at first bear a close resemblance to penitentes. Glacier penitentes and *névé* penitentes are of course the same, as far as the sun comes into play. Glacier penitentes run in rows corresponding to medial moraines, while *névé* penitentes follow the melting furrows of old snow.

As summer advances the surface of the snowfields turns into crackly foam, reminding one of the porcelain lace which one sees on figures of Dresden china. It makes going exceedingly disagreeable. From this there are innumerable transitions to the original and genuine penitentes of the Andes, namely isolated pillars, single or in rows, riding on screes. Those I saw favoured a south-eastern exposure. The climatic contrasts leading to these conditions—the heat desert of the lowlands sharply dovetailed into the cold desert of the highlands—are best illustrated by a curious combination which I found near the third glacier of the Tanimas valley. There an expanse of grey sand-dunes lay on the top of a floe of dead ice. It is these contrasts which make me believe in the great importance of the Alai-Pamirs to students of glaciology.

Round the Great Qara Köl and in the neighbourhood of the Tanimas pass one cannot fail to notice a certain resemblance to Arctic landscapes, say those of Greenland or Spitsbergen. Here one also finds the type of glacier known as the carapace as opposed to the snout-glacier. Enormous lobes of *névé*, instead of tending towards some depression and there forming a tongue, end abruptly in a vertical ice-edge about 10 feet high and often a mile or more in length. Snowfields of the Alpine type are usually frayed, a belt of snow-patches leading over to the dry slopes below. All the glaciers near the Tanimas pass come out of short corries and at their mouth suddenly spread out into large flat cakes. Where not impeded by old moraines and dead ice, these pancakes join together, notably on the top of the pass, where they also merge into the bay or overflow of the Fedchenko glacier, forming a vast Arctic expanse with ice-swamps.

Thus the top of the Tanimas pass is level with the surface of the Fedchenko glacier which pushes a slight bulge into the gap, causing a moderate overflow. A glacial tide in the Fedchenko basin will therefore give rise to a bifurcation and to a big Tanimas glacier. This then would explain the present width of the Tanimas valley, which to-day may be compared to a withered branch. The old Tanimas glacier must have pushed on into the Kokjar valley, there

being no other explanation for the landscape of terminal moraines in the flat basin east of Kokjar and the conglomerates which choke the gorge below Kokjar. To-day, with a few insignificant exceptions, the lateral glaciers of the Tanimas valley are all on the right or southern bank. Their ends form bars across the valley, leaving dry stretches in between. Any one conversant with the habits of glaciers will guess at once that this state of affairs must be the cause of catastrophes. This agrees with the native tradition of frequent and disastrous floods in the Bartang valley.

The Tanimas is the only big river which flows eastward at right angles from the Sel Tau for a considerable distance before it turns round and escapes by running along the range as the Bartang. The Pamirs as a whole form a kind of shelf slightly inclined towards the west, the watershed being that long line of low hills along which runs the Russo-Chinese boundary. The inner sides of the marginal ranges—Alai, Tagarma, Hindu Kush, Sel Tau—are drained by rivers sidling along the ranges, pressed against them, so to speak, by the compact block of the Pamirs. The Muk Su forms no exception to this rule, only that its upper reaches are not a river but a glacier, the Fedchenko. North of the Tanimas all glaciers and rivers are right tributaries of the Fedchenko–Muk Su system. The Nalivkin glacier, the immediate neighbour of the upper Tanimas river, flows in the opposite direction to the Tanimas. Owing to these topographical peculiarities the Kashal Ayak pass gives access to the north and to the south. Whoever crosses it from the Vanch valley has the choice of two routes, one leading down the Fedchenko glacier to Altin Mazar, the other over the Tanimas pass to the Bartang valley or to the Pamirs *via* Kokjar.

The Sauk Dara glacier repeats the tendency of the Fedchenko on a smaller scale. Hugging the southern flank of the Trans-Alai it does not curl round to the watershed until well past Pik Lenin. Our mountaineers coming from the west accomplished the final ascent from a saddle (5700 m.) on the eastern side of the peak.

DISCUSSION

Before the paper the PRESIDENT (Colonel Sir CHARLES CLOSE) said: Mr. Rickmers is to address us to-night on two journeys in Central Asia. The last journey in particular was begun on the western edge of the Pamirs. At an early age Mr. Rickmers took an interest in Central Asia and made some excellent journeys there. He is well known to us as the author of a book on 'The Duab of Turkestan,' which was published by the Cambridge University Press. Just before the war he had arranged, with a distinguished past-President of this Society, to go out to the Caucasus on an expedition; but about that time he was obliged to go to Vienna to be operated on for appendicitis. He was told by an expert that he could be made fit to travel in a fortnight, and so he was. But just when he was all right, the war broke out. Now, it was really very fortunate that our past-President and Mr. Rickmers were not together in those parts of the world, because they might have had to wage a private war of their own. I might add that Mr. Rickmers' father was a native of Heligoland. At one time I thought Mr. Rickmers himself had been born there, but he tells me that is not the case. Of course, we all know that in the '90's the nationality of that island was changed. Mr. Rickmers is a member of the Alpine Club, and he comes back to us as an old friend, for he lectured to the Society thirty years ago.

Mr. Rickmers then delivered his lecture, and a discussion followed.

Sir FRANCIS YOUNGHUSBAND: Mr. Rickmers said at the beginning of his lecture that the Pamirs was a word not to be mentioned on account of its political significance. Well, I was there when it was an exceedingly burning question, because in the year 1889 when I was first on the Taghdumbash Pamir, and in 1880 and 1890 on the Great Pamir and the Great Qara Köl lake, it was a question whether the inhabitants of that part were under the aegis of the Chinese or Afghans. They were all nomadic Qirghiz who were accustomed to bring their flocks up to graze on whatever they could find on those open valleys. They then owed allegiance, sometimes to the Chinese, sometimes to the Afghans, and it was exceedingly important for us in India to know whether the Russians would come and take them, or whether they would come under the Chinese. In the year 1891 the Russians did come down. They came across from the Altai valley over the Qara Köl lake that Mr. Rickmers has shown; they came down to the Great Pamir and Little Pamir and actually crossed the Hindu Kush range on to the Indian side of the great watershed. They came by the Baroghil pass and went back by a pass whose name I have forgotten. As I say, it was then a burning question.

As to the character of those Pamirs, I think from what Mr. Rickmers has described in words and from the beautiful pictures which he has shown, you will have gathered a thoroughly accurate impression. They are great wide open valleys, sometimes 5, 6, 8 or 10 miles in width, almost flat at the bottom and with mountain ranges on either side. Unfortunately the photographs give a wrong impression because they give altogether too low an idea of the height of the mountains. That is the fault of all photographs. I saw a photograph of the Qara Köl lake and there was a comparatively small range of mountains encircling it. As a matter of fact, it is a most beautiful range of snowy mountains, as I have it in my mind now nearly forty years after first seeing it. On those valleys there is very little to find in the way of fodder, but somehow the Qirghiz flocks, like those in Tibet, find something to graze on. Thus one finds little encampments of nomadic Qirghiz in their tents who seemed, certainly in my time, very well to do, and who had not then given up the custom—and I do not think they have yet—of wearing beautifully coloured dresses. Also in their tents they had beautiful carpets on the floor and round the walls. I was given a tent belonging to a Qirghiz chief to sleep in one night; it was really magnificently carpeted both on the floor and round the walls. I bought it from him in exchange for a carbine.

Mr. Rickmers noted the difference between expeditions then and now. In my time it was almost a necessity that one should go alone or with one companion. Now all that pioneer work has been done; expeditions are able to lay out beforehand a plan of operations, and we thus have such beautifully organized expeditions as Mr. Rickmers has described, with a leader who does all the organizing work. Although Mr. Rickmers has not said so, you can see how he has organized it all, leaving the various experts—zoologist, botanist, geologist, etc.—free to go about their particular jobs. That seems to be the method of exploration at the present moment, and of that method I gather the expedition that Mr. Rickmers has described this evening is a very notable example. I congratulate him very much indeed upon the excellent work hs has done and the lecture he has given, which conveys to us a splendid idea of the type of country that he has examined.

The PRESIDENT: Dr. Longstaff is with us to-night. He has been within 150 miles of the country Mr. Rickmers has described, and, therefore is fairly well qualified to take part in the discussion. Will he add a few words?

Dr. LONGSTAFF: My principal reason for responding to the President's invitation is the pleasure it gives me to speak on this occasion. I have had the privilege of the friendship of Mr. and Mrs. Rickmers for thirty years. Those of you who are interested in mountaineering will remember that in 1903 Mr. Rickmers led a party of celebrated German-Austrian mountaineers to the Caucasus. At the same time Rolleston and I independently went to the Caucasus. Both parties were of that happy age when personal rivalry is sweetest. We were racing each other for the last big batch of Caucasian peaks which remained unclimbed. Rickmers and his party were already in Suanetia. Rolleston and I had a very elementary knowledge of Russian, and we only had one Georgian servant. There is one awkward little bit of the journey after leaving the railway and civilization at Kutais to get into " Free" Suanetia, which was then unadministered territory. When Rolleston and I arrived at Kutais, eager to beat the German-Austrian climbers who were already established in Suanetia, we found Rickmers had sent his dragoman to meet us at Kutais in order that we might lose no time in commencing the competition! I think that is typical of Rickmers: he is well known as a thoroughgoing sportsman. Probably that is the reason why he is able to manage these large mixed parties on such expeditions as that of which we have heard to-night.

Now you will not want to hear much from me. I have not been within 100 miles of Qara Köl, but on the fringe of the Afghan Pamir; that is, on its mountain fringe. I advise all those who are in any way interested in the subject to make a point of reading Mr. Rickmers' paper when it appears in the *Journal*, for he has not read it to-night. You have heard his very interesting description of the cold desert meeting the hot or dry desert, and you get there an interesting interplay of many things which I must not now go into. Then there is the great Fedchenko glacier, which is probably 40 miles long; in fact, it is the second longest glacier in the world, outside the Polar regions and Alaska. The biggest glacier is the Siachen in upper Nubra, which is exactly 45 miles long and was discovered in 1909. The Fedchenko glacier, as far as I can make out from Rickmers' maps, is 40 miles long; the only other possible competitor is the Inilchek glacier, explored by Merzbacher in the Central Tian Shan. The Fedchenko glacier was discovered in the year 1928, so exploring is not yet by any means played out; its discovery was due to Rickmers' topographical insight.

Then there is Mount Kaufmann. I have not any patience with those who want to change the name Mount Kaufmann—the name of the great Governor-General of Russian Turkistan—to commemorate a politician. We must have an authoritative account for the *Alpine Journal* of this great ascent. Rickmers and I are both members of the Alpine Club and we are not supposed to talk about records, I know. You either get to the top of a mountain or you do not; and if you don't quite get to the top it isn't strictly an "ascent." Well, the record for twenty-one years has been Trisul, which is about 23,400 feet, a well-known peak in the Himalaya that was climbed to celebrate the Jubilee of the Alpine Club in 1907. We selected it for that purpose, because we knew that it was higher than any other mountain that had incontestably been climbed to the very top. Now, it is quite probable that Mount Kaufmann is as much as 50 metres higher; I think it is probably 7150 metres high. All the authorities give it as either 23,000 feet or 7000 metres, but I think this is an approximate value only. No doubt it will be in time accurately fixed, and I should not be surprised if it is a few metres higher than Trisul. Then Rickmers will have had also this to the credit of his expedition, that it is the highest mountain that anybody has ever succeeded in getting to the top of. Therefore from the point of view of a mere mountaineer I consider that that is very likely to prove a record,

and I am very happy indeed to be the first to congratulate my old friend on establishing what I believe to be a new record in the annals of mountaineering. I ask him to convey my heartiest congratulations to the climbing party on the accomplishment of a great ascent.

The PRESIDENT: When dealing with these great peaks we cannot be certain, within 100 feet or so, as to what the exact height is. I will not go into the technical reasons for that, but all who have studied the question of heights of mountains will know very well that we are, relatively, uncertain. We can call Everest 29,002, with a variation of 100 feet or so, and we shall not be very far wrong. There are special reasons why we do not know the exact height or how to define the exact height of these mountains. But whether the higher be Trisul or Kaufmann, we are quite sure that the climbing of each was a very fine feat, and we congratulate both Dr. Longstaff and Mr. Rickmers' party on their achievements.

Mr. Rickmers has clearly showed to us the advantage of a well-organized expedition. The sort of expedition he has described reminds us of what would be a well-organized boundary commission nowadays with its various experts and with a leader who has not only the duty of plunging his head into boxes containing food, as Mr. Rickmers observed, but other duties besides. On the purely technical questions and the use of photography, I was very glad to find that such a large area had been surveyed by Mr. Rickmers' party. He has given us a clear instance of the advantage of good organization for work over a relatively limited space, and the world is not yet fully explored : very far from it. Mr Rickmers mentioned that there were still some native tribes, totally unknown, which expected any day to be discovered. We may, perhaps, hope that they won't be discovered yet a-while. I thank Mr. Rickmers, in the name of the Society, for an admirable lecture, and congratulate him on the excellent work that his party carried out.

[*We are indebted to Mr. Rickmers for the opportunity which he has given us of obtaining for the Society's collection prints of a large number of photographs taken on the 1913 and 1928 expeditions. Among these are photographs of the snouts of the following glaciers: Garmo, Sildi, Fedchenko, Notgemeinschaft and Glacier III, Tanimas. These may prove useful records in future studies of the glaciers of the region.*—ED. *G.J.*]

THE QUEENSLAND COAST AND THE GREAT BARRIER REEFS: *A paper partly read at the Evening Meeting of the Society on 4 February 1929, by*

J. A. STEERS

1. (*a*) *The Great Barrier Reef Expedition*

THIS paper gives an account of the investigations of the Geographical Section of the British Expedition to the Great Barrier Reefs, originally planned to investigate certain biological problems. Its inception was due mainly to Sir Matthew Nathan and to Professor H. C. Richards of Brisbane, A Great Barrier Reef Committee has been at work for some years in Brisbane. and Sir Matthew was its chairman when he was Governor of Queensland. On his return to this country he formed an English Committee to act in conjunction with the Australian Committee, and this Committee dispatched in June 1928 a party of twelve biologists under the leadership of Dr. C. M. Yonge of the Marine Biological Station at Plymouth and Balfour Student in the University of Cambridge. This party had its base on Low Islands, a small low wooded island near Port Douglas in North Queensland.

The Geographical Section of the expedition was sent out under the auspices of the Royal Geographical Society, who financed this section, and also provided a number of surveying instruments. The Society was actuated in this by a desire to obtain information about the major problems of the Barrier which could not well be investigated by a party with its base in one area and thus necessarily restricted in the scope of its work. The Geographical Section, though attached to the main party, worked as an independent unit. It consisted of M. A. Spender of Balliol College, Oxford, and the writer. E. C. Marchant of St. John's College, Cambridge, joined the party for a short time and stayed on Low Islands for a further six weeks. This party, during the latter part of 1928, made a reconnaissance along the Queensland coast and adjacent reefs. The cruise was made in a small boat of about 14 tons, the *Tivoli* of Townsville, and extended over the whole distance between Whitsunday Island and Flinders Islands, in which many high islands, low wooded islands, sand cays, reefs, and parts of the mainland coast were visited. Apart from the cruise in the *Tivoli* the writer made a journey from Brisbane to Mackay in the Commonwealth lighthouse ship *Cape Leeuwin*, and was thus enabled to see a good deal of the Queensland coast south of the Barrier Reefs, and also something of the southern end of the Barrier itself, including Lady Elliott Island (the most southerly coral islet of the reefs) and North Reef. The opportunity was also taken, when re-provisioning at Cairns, of making a rapid, but interesting trip inland to Atherton by way of Gordonvale and the new Range Road, and back by rail through the well-known Barron Gorge. In this way a great deal of the Barrier region was seen, and even if our visits to islands and reefs had to be rather short, we were able to form a useful impression of this particularly interesting region as a whole. Years of work by many specialists are necessary before we can claim to be intimate with this, the greatest coral reef of the world. The Australian Great Barrier Reef Committee, under the able chairmanship of Professor H. C. Richards of Brisbane,

is doing much to inspire interest in the Reefs and their problems; it is hoped that this paper may, in a small way, interest geographers at home.

1. (*b*) *Arrangement of the Paper*

This paper deals with several matters other than the origin of the Barrier Reefs. The origin of the Reefs is the chief problem which the writer has in view, but in an investigation such as the party was able to make, many other points subsidiary to the main problem, but necessarily inextricably involved in any account of the Reefs, had to be considered. Hence the *sections* of the paper are more or less independent entities. Where necessary some of the sections have been divided into *chapters*.

Many workers have written on the Barrier Reefs, and a discussion of their views is contained in Sections 2 and 9. The general conclusion of the writer is that the main element involved in the formation of the reefs is the faulting of a series of crust blocks and attendant submergence with which reef upgrowth has gone on concurrently. Much of the evidence for this has necessarily to be obtained from accounts of the geology and physiography of the mainland and coasts of Eastern Australia. It has been necessary to refer frequently to previous papers and often to quote from them. The main object of this paper is to focus attention on the evidence for faulting.

In addition, the paper contains new material and views on the nature and origin of low wooded islands and sand cays. Many of these were visited in the course of the cruise, so that we were able to compare their structures and draw some general conclusions. Several other problems, which have been occasionally touched upon by earlier writers, have also been elaborated here, and, it is hoped, some new light has been thrown upon them. In particular, mention may be made of the evidence for recent uplift along the East Australian Coast, the formation of sand and shingle spits, and the question of cliffing. There is a great deal of literature dealing with the reefs and related problems to be found in Australian journals and other publications. Much of this has not yet been brought together or found its way into English scientific literature.

Before concluding this introductory statement, the writer would like to acknowledge fully and sincerely his thanks for the great assistance and kindness which the geographical party received in Queensland. This was very largely due to Professor Richards and his Committee, who gave every possible help, and to Mr. Butler and his nephew, George Hollins, whose services on the cruise were invaluable. Full acknowledgment must also be made to the Worts Fund in the University of Cambridge, and to the P. and O. and Orient Shipping Companies, who very kindly granted free return passages to Australia to two members of the Geographical Section. Lastly, the writer would like to take this opportunity of thanking all those who have helped him by making suggestions and criticisms and in other ways, in preparing this account, especially Mr. F. Debenhan, Professor S. Gardiner, Mr. P. Lake, Mr. L. F. Newman, Mr. F. A. Potts, Professor E. W. Skeats, Dr. H. D Thomas, and Dr. C. E. Tilley.

2. *Summary of Views of Previous Investigators*

In order to make this account fairly complete it is convenient to give here a short summary of the views of others who have written on the Reef. In various

parts of this paper references will frequently be made to particular points in their writings, but these references will not in themselves be sufficient to give the main views of any one writer, and so it is relevant to outline those views in this place.

Cook was the first to give an account of this region, but he did not express any views on the origin of the Barrier. His was a voyage of exploration, and was carried through under great difficulties. A modern navigator finds Cook's names all along the coast, and he marvels at the way in which Cook carried out his voyage through uncharted seas infested with dangers. No early navigator could regard the lagoon as "Australia's Grand Canal" if by such is implied a safety zone. Flinders did not concern himself greatly with the origin of the Reef, although he speculated on it. He first drew attention to, and named, "Negro heads," and made some general remarks on the formation of cays. Flinders' work, like Cook's, was mainly exploratory.

The first scientist to speculate on the Reef was Beete Jukes, the naturalist on H.M.S. *Fly*. He was in the Reef waters from 1843 to 1847. To him all subsequent writers owe much. He was a remarkably accurate observer. Although often quoted, it will not be out of place here to give Jukes' own words on the Reef:

"The Great Barrier Reefs are thus found to form a long submarine buttress along the north-eastern coast of Australia, rising in general precipitously from a very great depth, but resting towards the north on the shoaler ground of Torres Strait and towards the south on the bank stretching off from Sandy Cape. If it were to be laid dry this great barrier would be found to have a considerable resemblance to a gigantic and irregular fortification, a steep glacis crowned with a broken parapet wall, and carried from one rising ground to another. The tower-like bastions of projecting and detached reefs would increase the resemblance."

Jukes illustrated his account with the cross-section reproduced in Fig. 1. He regarded the reef as very thick, and states that reflection convinced him that its origin was best explained by Darwin's* theory. Further, Jukes appreciated the movements first of subsidence and later of recent uplift on the Queensland coast.

Alexander Rattray, who, as surgeon on H.M. Surveying Ship *Salamander*, had very good opportunities of seeing out-of-the-way places, wrote an account of considerable value of the mainland geology of the Cape York Peninsula,† and pointed out the connection between the foundering of the eastern side of this peninsula and the origin of the Reef. Tenison-Woods also wrote a paper‡ on North Queensland Geology, and anticipated modern writers by pointing out the value of studying the high islands, which he regarded as giving evidence for subsidence of the Reef area. Dr. A. C. Haddon§ wrote an account of the

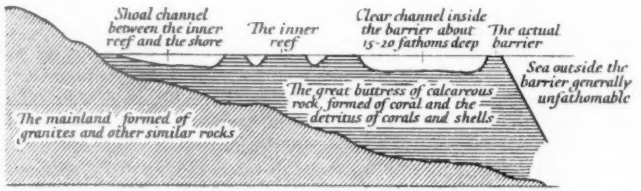
*See 'Coral Reefs,' C. Darwin, "Minerva" ed., esp. pp. 42 and 93. Darwin's views are so well known that it is hardly necessary to say more here than that he regarded a barrier reef as an advanced stage—due to further submergence with accompanying upward growth—of a fringing reef. He appealed to simple submergence on a large scale.

†*Quart. J. Geol. Soc. London*, 1869, p. 303.

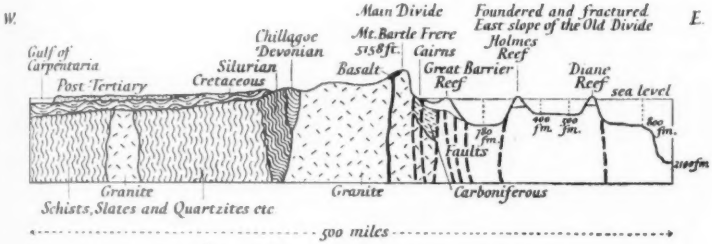
‡Apparently published in *Proc. Queensland Phil. Soc.*, 1880. See also *Brisbane Courier*, 6 and 25 July 1881.

§*Trans. Roy. Irish Acad.*, vol. 30, 1894.

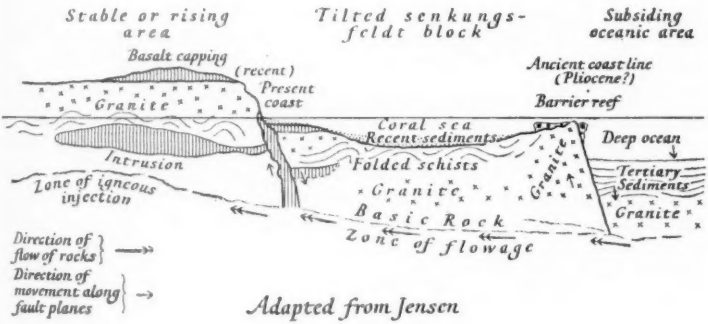
SECTIONS ACROSS THE GREAT BARRIER REEF


Shoal channel between the inner reef and the shore
The inner reef
Clear channel inside the barrier about 15-20 fathoms deep
The actual barrier
Sea outside the barrier generally unfathomable
The great buttress of calcareous rock, formed of coral and the detritus of corals and shells
The mainland formed of granites and other similar rocks

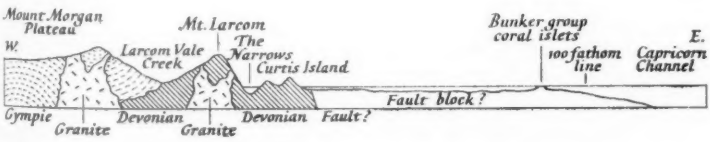
After Jukes



After Edgeworth David (Section through Cairns)



Adapted from Jensen



After Jardine (Section through Curtis I. and Bunker Is.)

Fig. 1.

volcanoes in the Torres Straits islands. Hedley and Taylor* refer to this paper and clearly regard the evidence thus afforded as indicating subsidence:

"One of the chief gains to science in the investigation of Funafuti was the generalization that crystallized dolomite characterized the strata below 638 feet, but was unknown above that horizon. . . . Now, large blocks of dolomitic coral were observed to have been ejected by the extinct crater of Mer, Murray Islands, north end of the Great Barrier, by Professor A. C. Haddon. . . . These blocks have been examined *in situ* by one of us (*i.e.* Hedley). This shows that the volcanic pipe burst through an underlying coral reef. It seems a fair deduction to conclude that at this spot sunken reefs exist below the 100-fathom level."

Saville Kent's† main work was biological and photographic, and his pictures of coral growths are well known. He held much the same views as Darwin and Jukes on the origin of the Reef, but his conclusions are rather unconvincing.

Alexander Agassiz‡ travelled over a good deal of the Barrier region and was able to make comparisons with the many other reefs he had visited. He took a distinctly different view from Darwin and regarded the reefs as a comparatively thin veneer on a continental shelf. He thought that this shelf had been stationary since the Cretaceous. To quote Agassiz:

"We assume for the corals a thickness that can be determined fairly accurately as only a veneer of at most twenty fathoms upon the faces of the denuded platforms of the islands which once formed the outer line of the Australian continent, the remnants of which are still left as monuments of such a connection in the numerous islands scattered along the whole length of the Queensland coast at various distances between the mainland and the line of reefs forming the outer edge of the Great Barrier Reef. The geological structure of these islands plainly indicates their former connection with the Australian continent."

The difficulty in this explanation lies in the fact that Agassiz held that the islands were separated from one another and from the mainland by erosion. Quite apart from the improbability of this factor alone, it is not clear whether this process went on before or after the growth of the reef. If the former, why was there such a delay between the formation of platforms and islands and the inauguration of the reef? If the latter, how could the lagoon waves possibly account for this amount of erosion? Although Agassiz' great experience carried weight, we cannot regard his views on the Great Barrier seriously to-day. And, as shown elsewhere, his views on Negro-heads were also erroneous.

Modern physiographical methods were first applied to the study of the Reef by E. C. Andrews in 1902 and 1910.§ His studies of the New England

**Reps. Aust. Ass. Ad. Sci.*, Sect. C, 1907.

In the light of Professor Skeats' work on dolomite, the inference drawn by Hedley on Mer is of very little value. Skeats' evidence shows that the dolomite is a shallow-water phenomenon, and its occurrence only below 638 feet at Funafuti is to be regarded as indicating subsidence (see *Q.J.G.S.*, 1905, and *Am. J. Sci.*, 1918).

†'The Great Barrier Reef of Australia,' London, 1893. See also review by Forbes in *G.J.*, 2, 1893, p. 540.

‡*Bull. Mus. Comp. Zoo. Harvard*, vol. 28, No. 4, 1898.

§*Proc. Linn. Soc. N.S.W.*, vol. 27, 1902, pp. 146 *et seq.*; and *J. and Proc. Roy. Soc. N.S.W.*, vol. 44, 1910, pp. 420 *et seq.*

District and of the Queensland coast showed how unstable these areas have been since the Cretaceous period. He stated emphatically that problems connected with the reef were possibly best attacked from a study of the associated coast and plateau topography. He concludes:

"The formation of the present Great Barrier Reef probably does not antedate this last movement of subsidence (*i.e.* late Pliocene and Pleistocene), although reefs doubtless existed prior to the cycle of subsidence. Unless the movements of subsidence were accentuated in an easterly direction, the depression which determined the Barrier Reef must have been very moderate in amount. Were a bore put down in the Great Barrier Reef, it would probably show a very moderate thickness only of bedded recent or at most Pleistocene coral lying on mud, stones, conglomerates, and limestones of Pliocene age."

In a sense this is an intermediate view between that of Agassiz on the one hand and Darwin on the other. Andrews also fully recognized the recent movement of emergence.

In a paper published in 1922* Andrews appears to take a rather different view. He writes there:

"During the Pleistocene, therefore, the stable blocks, such as Australia, were subjected to the action of storms, waves, and currents which resulted in the development thus of continental and island shelves. During the interglacial period these platforms were submerged and were covered by coral reefs associated with submergence."

It would seem that Andrews' views have changed somewhat and that now he is a supporter of Daly's Glacial Control Hypothesis.

The views of Hedley and Taylor† on Cays and Negro-heads are referred to elsewhere. On the origin of the Barrier they are explicit. On these grounds they believe Darwin to have been right:

"1. That the mainland of Queensland shows subsidence. 2. That the sinking of the Queensland Coast is part of a general movement which affected the whole of Eastern Australia and Tasmania; probably correlated with an upward movement in the Australian interior between the 135th and 140th meridians, and perhaps on the north shore of the Papuan Gulf; the Barrier trough thus ending in the Fly River. 3. That the Barrier *does* present (which has been denied) a steep outward face agreeable to the Darwinian hypothesis. 4. That ejections from the Murray Volcano‡ show coral formation to occur there at considerable depths. And 5. That maturity . . . of the northern reefs indicates slow subsidence followed by quiescence."

In 1914 W. M. Davis paid a visit to the Reef.§ It will not be necessary to say much of his views here, as they are discussed in other parts of the paper. His world-wide knowledge of coral reefs enabled him to visualize Barrier Reef problems far better than any previous observer. On the other hand, he has had comparatively little field experience of the Australian reef area.

**J. and Proc. Roy. Soc. N.S.W.*, 1922, Pres. Address, pp. 10–38.

†*Reps. Aust. Ass. Adv. Sci.*, Sect. C, 1907, p. 397. See also Hedley, *Am. J. Sci.*, Series 5, vol. 11, 1926, pp. 187–193.

‡Cf. Haddon, Sollas, and Cole, *Trans. Roy. Irish Acad.*, vol. 30, pt. xi, 1894, pp. 419–476; and see note *, p. 236.

§*Am. J. Sci.*, Sect. 4, vol. 44, 1917; and 'The Coral Reef Problem,' pp. 345–363.

It must suffice for the moment to say that he found abundant evidence for assuming the Barrier Reefs to have been formed during subsidence in the manner Darwin suggested. It is, perhaps, fair to say that Davis has allowed hypothesis to play a rather large part in his account of this Barrier, but his vast knowledge and able generalizations have thrown much light on the methods of studying the reef. A still more recent suggestion is due to Sir Gerald Lenox-Conyngham,* who follows Hedley and Griffith Taylor fairly closely, but suggests that the "tectonic rocking" referred to by these authors may be connected with a world-wide movement such as is postulated by Joly in his well-known views on the surface history of the Earth. In other words, he seeks to give a reason for the facts pointed out by Hedley and Taylor.

Richards and Hedley† in 1923 spent some time off the Cape York Peninsula and added much to our knowledge of that remote region. They have suggested that the east coast of this peninsula shows strong evidence of rectangular faulting. Both these authors have made several visits to various parts of the Barrier, and it is largely due to them that the present interest in Queensland coral problems is due. The foundation and organization of the Barrier Reef Committee are due to Richards, and workers in all branches of science connected with the Reef are much indebted to him for the great help he is able to give. It may be mentioned here that Richards pictures a considerable thickness for the reef, and seems to think that the upgrowth of the coral took place during submergence and foundering.

Many other writers have said something of this reef—Gardiner,‡ Daly,§ and Vaughan‖ regard the coral as but a thin veneer. Daly, in his Glacial Control hypothesis, asserts there were no reefs here or around New Caledonia during the Pleistocene glaciation, but does not assume the necessity of the platform, on which he allows the reefs to rest, to have been wholly cut by Pleistocene benching. Vaughan holds that the reef is an upgrowth on a platform formed independently of the reef, which has recently suffered a small submergence. Stanley¶ and Jardine,** to whom reference is frequently made, have also expressed views on the origin of the Barrier, but their work has been mainly in particular areas. Stanley's general conclusion with regard to the origin of the Barrier is: "One believes that the pre-glacial reefs grew on the flexed and faulted-down margin of the Pliocene continent." Jardine also speaks of "the foundered continental shelf."

From this cursory survey it will be seen that observers fall into two classes—

*_G.J._, 65, 1925, p. 314.

†'Reps. Gt. Barrier Reef Comm.,' vol. 1, 1925, pp. 1–28.

‡_Proc. Cambridge Phil. Soc._, vol. 9, 1898, pp. 417–503; and discussion _G.J._, 65, 1925, p. 314.

§_Am. Acad. Arts and Sci._, vol. 5, 1915, p. 198; and _Am. J. Sci._, Series 4, vol. 41, 1916, p. 181.

‖_Bull. Geol. Soc. Am._, vol. 27, 1916, p. 41; _Am. J. Sci._, Series 4, vol. 41, 1916, pp. 131–135; Smithsonian Inst. U.S., _Nat. Mus. Bull._, 103, 1919, pp. 189–524.

¶"The Physiography of the Bowen District and of the Northern Islands of the Cumberland Group (Whitsunday Passage)," Reps. Gt. Barrier Reef Comm., vol. 2, 1928, pp. 1–51.

**"The Physiography of the Port Curtis District," Reps. Gt. Barrier Reef Comm., vol. 1, 1925, pp. 73–110.

those who regard the reef as a thin veneer on a platform, and those who regard it as definitely favouring subsidence such as Darwin postulated. In the former class there are some who will allow a slight submergence. It is probable now, largely due to the influence of W. M. Davis, that most writers on coral problems see evidence for submergence. The writer of this paper finds himself on the side of those favouring subsidence on a fairly extensive scale, though not necessarily of equal amount in all parts of the Barrier, and he regards the subsidence as having been due partly to simple warping and partly to faulting.

3. (*a*) *Geology and Physiography of the Queensland Coast*

Before proceeding to details, it will be well to give a short summary of the geology of the mainland coast. Between Cape York and Cape Melville there is a succession of bays, opening to the north and bounded to the east by capes—Turtle Head, Orfordness, Grenville, Fair, Weymouth, Direction, and Melville. Richards and Hedley have described the geology of this area and note that all these capes, except Turtle Head and Orfordness, are granitic, the exceptions apparently being low-lying sandstone cliffs. "Behind the headlands and forming Cape York Peninsula proper we have a more or less continuous series of flat-bedded sandstones stretching from Albany Island right down to Indian Head, and Mount Saunders, just north of Cooktown."* South of Cape Melville there are other minor headlands which were not examined. Then come Capes Flattery and Bedford. The former is particularly interesting as it shows an unconformity, faulting and benching. The main rocks appear to be coarse sandstones resting on contorted metamorphics (?). Cape Bedford seems to be formed largely of sandstones, but South Cape Bedford, which was not examined, is different, and from the offing appeared to be formed of old Palaeozoics of a schistose nature. The sandstones of this northern area are probably Jurassic and are unconformable to the underlying Palaeozoics and granites. Look-out Point is an exposure of these Palaeozoic rocks.

South of Cooktown it is not easy to make any generalizations: southwards to the neighbourhood of Mourilyan Harbour Palaeozoic rocks, usually much metamorphosed, fringe the shore, but some of the prominent headlands, such as Cape Grafton, are granitic. South of Mourilyan many of the headlands and islands are granitic, as also is the coast range. Between the latter and the sea are basins of post-Tertiary rocks, as around Ingham and Townsville, and through which rise granite residuals. Cape Cleveland, again, is a granite headland. To the south is the Burdekin delta and Cape Bowling Green, a long sandspit. Around Bowen Stanley† notes much granite, Bowen itself being situated on a great bathylith. Some of the Cumberland Islands are of granite, but others are of altered volcanic rocks which are thought to be of Permo-Carboniferous (Lower Bowen) age. To the south, again, flat areas of Recent rocks occur, but from St. Lawrence down to beyond Gladstone and Port Curtis there is a series of slates, schists, quartzites, etc., which were assigned somewhat doubtfully to the Ordovician, but are now thought to be Silurian to Devonian. Here, too, granite every now and again appears.

*Reps. Gt. Barrier Reef Comm., vol. 1, 1925, pp. 1–28.
†Reps. Gt. Barrier Reef Comm., vol. 2, 1928, pp. 1–51.

South of Bundaberg the mainland coast is protected by Great Sandy Island (Frazer Island), whose northern arm encloses Hervey Bay. The mainland thus enclosed consists mainly of the Rolling Downs Formation (? Lower Cretaceous) and the Ipswich Beds. Finally the Moreton Bay district is faced with the sand-dune islands—Bribie, Moreton, and Stradbroke, where occasional exposures of older rocks occur.

So much yet remains to be studied in Queensland geology that the above notes must be regarded as but a rough indication of the actual facts. Indeed, the generalization made by Griffith Taylor:* "In the east, along the coast, extends a belt of ancient granite ranges often pierced by deep gorges whence the coastal streams now reach the sea" sums up the matter fairly well, if allowance be made for the sandstones of the Cape York Peninsula and the local developments noted above. It may here be remarked that the nomenclature of Queensland stratigraphy is very confused, and geologists will be grateful to W. H. Bryan for his recently published glossary,† which does much to clear up this confusion.

Physiographically the Queensland coast is a typical drowned coast.‡ Throughout its entire length there are numerous deep embayments which are only partially filled with river alluvium. Only the Burdekin§ has made a delta which forms an excrescence on the coast. All the other streams have not yet had time to fill up the embayments into which they flow. Looked at on a big scale the coast is steep-to. The hills plunge straight down into the lagoon. Where flat low-lying areas fringe the shore, they are all of recent alluvial materials.

The numerous rocky off-shore islands are formed of rocks similar in every way to the adjacent mainland. They, too, are deeply embayed and were once clearly connected with the continent. The way in which they were severed was, and perhaps is still, a point about which writers differ. Nevertheless, the majority of observers, and especially modern observers, are in accord in thinking that they have been severed by submergence and not by erosion. The latter hypothesis was held by Agassiz, and some of the other writers who hold that there is only a thin veneer of coral resting on the continental shelf would seem to imply that the separation of islands and mainland has been due, partly, to erosion. An inspection of large-scale charts which show the intricate island patterns is, in itself, a strong argument against the erosion hypothesis.

The last movements to which the coast has been subjected have been elevatory and of small amount, and so now some of these "islands" have been re-included in the mainland either by tying by tombolos, as seems to have happened in the cases of Capes Bedford and Flattery, or by the spread of alluvial material around them, as, for example, around Townsville, where the granite residuals now rise from a flat alluvial plain (see later).

*'Phys. and Gen. Geog. of Aust.' Reprinted from Federal Handbook issued in connection with visit of British Association to Australia, 1914.

†'A Glossary of Queensland Stratigraphy,' The Carter-Watson Co., Ltd. (University of Queensland), Brisbane, 1928.

‡Cf. An early description by Penck, A., in *Vorträge Vereines zur Verbr. naturw. Kenntnisse in Wien*, 36, 1896, No. 13.

§Hedley and Taylor, *Aust. Ass. Adv. Sci.*, 1907, Sect. C.

David* summed up the matter as follows:

"From Gladstone to Cape York there is a remarkable coast, chiefly of the rückland type, with mountain ranges from 2000 feet up to 5000 feet high (Bellenden Ker 5428 feet) coming mostly close to the coast-line, and having high islands like Hinchinbrook, which rises to an altitude of 3560 feet close in shore. This part of the coast and coastal shelf is so heavily faulted and studded with small islands, which have survived the block-faulting, as to deserve Suess' title of *panzer-horst*. In places there is a coastal plain, as at the Jurassic (or Cretaceous?) coal-basin of Broad Sound, at Port Mackay, and to north-west and south-east of Townsville . . ., in others, old rocks, chiefly Carboniferous strata, . . . or Devonian rocks . . . both systems intruded by granites, form bold cliffs and headlands."

3. (*b*) *General Description of the Barrier Reefs*

The reefs along the Queensland coast do not form a continuous barrier. In fact, the term "Great Barrier Reef" is, in some ways, extremely misleading. The Barrier really consists of a number of reefs and reef patches cut up by many channels. Sometimes these channels are several miles wide, as, for example, Trinity Opening, off Cairns. In other cases the channels are narrow and very difficult to navigate. Further, the Barrier, even in the sense defined above, is not continuous from Thursday Island in the extreme north to Lady Elliott Island in the extreme south. The farther south it is traced the more broken it becomes, and finally resolves itself into a series of widely separated patches a very long distance from the coast. In fact, the Bunker and Capricorn groups of islands can almost be considered as distinct from the so-called Barrier proper. Thus it is, roughly speaking, only to the north of Cairns that the reef is strictly a Barrier Reef. From here northwards it is much more continuous and is also much nearer the coast.

Its distance from the coast is worth noting. Lady Elliott Island, the most southerly island of the reef area, is about 50 sea miles distant from the nearest point on the mainland. A little to the north of Lady Elliott Island the Barrier is nearly 100 miles from the coast, and off Townsville its inner edge is nearly 50 miles away. At Cape Melville it is closer to the shore than anywhere else (about 7 miles), and at Cooktown the inner edge is about 18 miles and the outer edge nearly 36 miles from the mainland. Probably there is much open water between these two limits: surveys are not yet complete of this part of the reef.

The "lagoon" is thus in reality a sea of considerable width. This is a point of the first importance. It is perhaps worth mentioning that the "lagoon," at any rate south of Townsville, is in most places almost as wide as the eastern part of the English Channel. This comparison is also of interest in another way: The effects of a south-westerly gale in the Channel are well known. In the lagoon the south-easter is the corresponding feature. Very considerable seas are common in this lagoon, and when the South-East Trades are blowing, rough water occurs even where the lagoon is narrow, as near Cape Melville.

*'Geology of the Commonwealth.' Reprinted from Federal Handbook issued in connection with visit of Brit. Ass. to Aust., 1914. See also Suess, 'Face of the Earth,' French Trans., vol. 3, part 3, p. 1003.

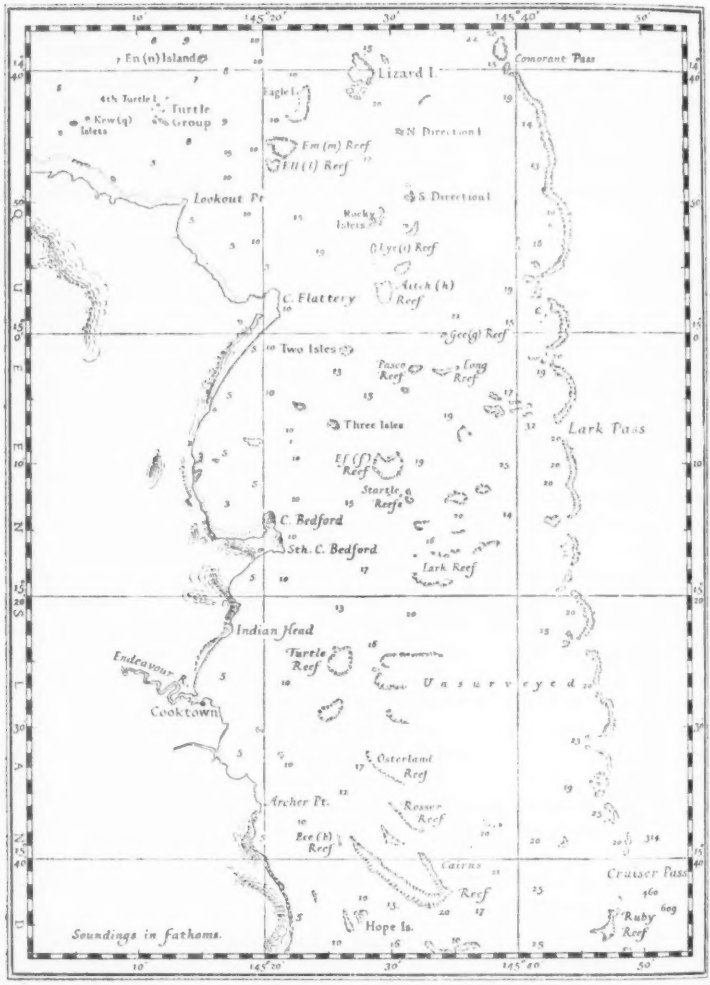


Fig. 2. Sketch-map of Queensland Coast from Turtle Group to Hope Islands with adjacent Barrier Reefs: from Admiralty Chart 2923

This, as will be seen later, is of no little importance when considering the question of cliffing and other physiographical features.

Within the barrier there are many islands and reefs. The islands may be divided roughly into high or rocky continental islands, low wooded islands, and sandy cays. The former are often partly or wholly surrounded by a fringing reef. The two latter stand on patches of reef. Also within the Barrier, more especially in the northern parts, there exists an inner series, much less continuous, of minor reefs. These are not all crowned by a low wooded island; many are in every way similar to the outer reefs, and may be partly dry at low water springs. Along the mainland there are occasional patches of fringing reef, as, for example, that near Donovan Point, and those to the south of Port Douglas.

The depth of the lagoon varies within small limits, roughly between 10 and 25 fathoms. But reference to the part of the chart reproduced (Fig. 2) will serve to bring out the depths far better than a long description. Inside the Whitsunday group of islands surprising depths are found, in one case 50 fathoms being recorded. Although there are slight variations in the depths, the lagoon floor is, to all intents and purposes, relatively flat. It is probable that this flatness is, in large part, due to sedimentation. It is almost impossible to trace any of the old river channels across this floor, and this is a strong argument in favour of considerable sedimentation. In the far south a large "gulf" intervenes: between the Bunker and Capricorn group and the mainland almost oceanic conditions occur.

It is only natural that in this island-studded lagoon currents and tides should be very complex. But in a general way the major drift is northwards with the prevailing south-east winds. That this is so is evidenced in several ways. On nearly all the continental islands, and on many parts of the mainland, there are sand-spits which always point in a northerly direction. Such spits are wave formed for the most part, but the waves, in turn, are the product of south-east winds. Again, at the northern end of Breaksea Spit (*i.e.* the north end of Frazer or Great Sandy Island) there is a lightship. This has broken loose on more than one occasion. The writer was on the lighthouse ship *Cape Leeuwin* on one of those occasions, and in four or five days the lightship was found to have drifted from its moorings at Breaksea Spit to within a mile or so of Heron Island, a distance of over 80 miles. This prevailing northerly drift is of considerable physiographical importance in the reef waters.

It is not easy to get a general view of the disposition of the outer reef. Perhaps the best view is from the summit of Lizard Island.* From this point, 1179 feet high, the outer barrier can be clearly seen. In this area the separate reefs form a single cordon broken every few miles by gaps. The reefs are usually somewhat crescentic, the convexity facing the Pacific. The existing charts of this area look rather conventional: it is interesting to view the reefs from this summit and see how realistically the charting does represent the actual appearance of the reefs. To north and south of this area the reefs are rather more complex, and may break up into one or more lines or series. In such cases the Barrier is often several miles in width.

*This is the island from which Cook sighted his means of escape from the lagoon.

4. *Islands*

(*a*) *The High or Continental Islands*

The majority of the islands in the Reef Seas belong to this category. It is impossible here to give a detailed account of them, and only certain matters of general interest can be alluded to. In dealing with the origin of the reefs, further reference will be made to them.

It is essential to note that all these islands are formed of rocks similar to the near-by mainland. They are, in fact, just severed and partially drowned portions of the Australian continent, and point to a time when this land mass extended much to the east of its present limits. There are certain islands and groups of islands which have been fully described by other writers. Stanley has studied the Whitsunday Group and adjacent islands and mainland. Jardine has written on the Port Curtis district. Richards and Hedley deal with the Flinders Islands. Several others have described particular islands—for example, Agassiz; Holborne Island has been fully described by Marshall, Walkom, and Richards; Raine Island by Beete Jukes.

Most of these islands are forested, often very dense rain forest covering all the island. Exploring such islands is a matter of some difficulty and requires much time. The forests frequently come down to within a few feet of the water and run right up to the summits. The photograph of the weather side of Dunk Island is quite typical. On the other hand some islands have very few trees on them. It is not easy to see why this is so. In the absence of corroborative detail it is not improbable that the nature of the weathering and the soil have much to do with it. As a general rule islands of igneous rock seem to be more densely forested than are those formed of metamorphics and sedimentaries. Unless examination were made of every island the absolute truth of this statement could not be maintained, but taking, for example, the stretch of coast between Townsville and Cairns, we find the islands are very largely of granite or of other igneous rock, and that they bear dense forests.

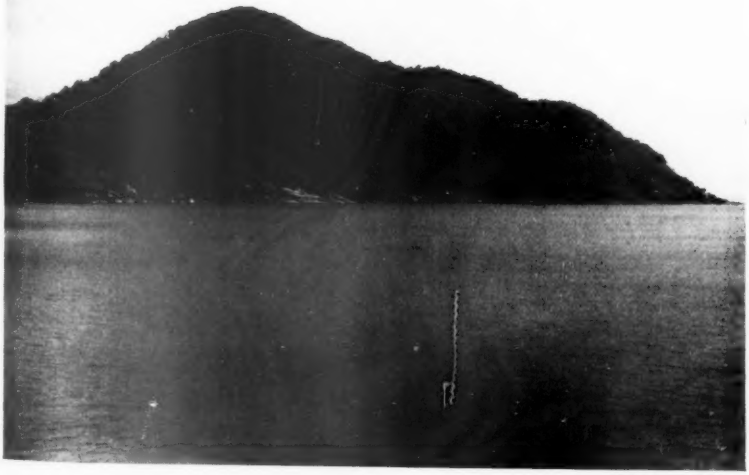
In the north, where metamorphic and old Mesozoic sedimentary rocks crop out, the vegetation is sparser, and this is very noticeable in the Flinders Islands district, where the islands are of sandstone. On the weather side of these northern islands winds may play an important part in the matter: the strong and persistent Trades must make it difficult for vegetation to thrive. The whole subject would form an interesting inquiry for an ecologist. The Whitsunday group is, for the most part, well forested, at any rate on the slopes facing the Whitsunday Passage. On the other hand, farther south, many islands, such as the Beverley Islands, are grassy on their windward slopes.

Many of the larger islands show evidences of dissection very clearly. They are cut up into deep valleys which radiate out from a central peak, or, if the island be elongate, the valleys furrow the longer sides, as, for example, on Gloucester Island and Hinchinbrook Island. Stanley writes of Whitsunday Island: "Again, like Hook Island,* the dissection of the island is deep and well advanced. Great gullies lead from the head of deep embayments, such as Hill Inlet and Gulnare Inlet. In the former, the island is all but truncated by the length of the gorge." Hinchinbrook Island contains many peaks rising

*Hook Island is the next island to Whitsunday Island and on its northern side.

Phot. M.A.S.

1. Cape Flattery and bench



Phot. M.A.S.

2. The weather side of Dunk Island

Phot. M.A.S.

3. The Family Group

to 3000 feet or more. There are deep gullies and valleys between these peaks. The island is the most magnificent on the whole of the Queensland coast. It stands up as a great mountain mass, nearly equal in height to the mountains on the adjacent mainland. It is separated from the mainland by a narrow but deep and picturesque channel, now much contracted by mangroves fringing the mainland and the island shores of the channel. The island itself is divided by a low and broad valley into two parts, the southern, apparently largely of granite, being the higher and bigger. Here the peaks are truly mountainous and rugged and afford the finest coastal scenery in the Barrier region. The northern part of the island contains Mount Pitt, a peak which reaches 2350 feet, but the outlines are less bold and rugged. This deep valley may possibly be a structural feature, but not much is known of the geology of the island, and its densely forested nature makes it very difficult to explore. However, the striking differences in profile between the northern* and southern parts strongly suggest some differences in rock composition. A climb up to about 2000 feet near Mount Straloch traversed granite nearly all the way. On the other hand, the unnamed cape (really a small island "tied" to Hinchinbrook Island) on the east side of Missionary Bay is formed mainly of a gneissose rock.

Before leaving the question of the dissection, by subaerial erosion, of these islands, attention must be given to the fact that the seaward ends of the valleys and gullies are nearly always filled with alluvium and silt, with forests or, more probably, mangrove swamps. In such cases a flat alluvial area occurs, and sometimes when there are many such gullies, a fairly complete alluvial fringe occurs all along an island. In this we see one of the lines of evidence for the recent slight uplift which has affected this coast (see later).

Viewed from a boat, or any commanding position, these high islands resemble nothing so much as partially submerged mountain masses. Often the slopes are nearly unbroken down to water-level, and where the islands are in groups the similarity to drowned mountain areas is so great as to leave no reasonable doubt as to the general nature of their origin. This is strikingly seen in the Whitsunday group and the Palms. Where the islands are smaller, they usually stand up as rounded knobs, as, for example, the Family Group. The granite of which these particular islands are formed has weathered into smooth rounded masses, and is covered with dense vegetation extending down to within a few feet of the water. Viewed from Richards Island or Dunk Island they form one of the most beautiful scenes on this coast.

These high islands vary much in their distance from land. Some merely fringe the coast, others, such as the Palms, and still more the Lizard Group, stand well away from the land. But in all the larger the amount of dissection shown is considerable. The Lizards and North and South Direction Islands are perhaps the most isolated of these high islands; Look-out Point, the nearest part on the mainland, being about 16 miles distant. Even this minimizes the effect, because Cape Flattery itself, which is about 18 miles away, is apparently a high island which has become joined to the mainland by a tombolo.

Brief reference may be made here to the matter of cliffs on these islands. Sometimes the islands, even on the weather side, slope gradually upwards

*Andrews mentions quartz-porphyry in the northern part (*Proc. Linn. Soc. N.S.W.*, vol. 27, 1902, pp. 146 *et seq.*).

without any sign of cliffing. Dunk Island and parts of Curaçoa are very good examples. Lizard Island also has practically unbroken slopes. In other cases, however, the islands are precipitous and cliffed. As suggested later in this paper, the question of cliffing seems to be very largely controlled by the nature of the rock of which a shore is made. Exposure, apparently, is rather a secondary question.

On the other hand, Flinders Islands, formed throughout of sandstone, present rather different features. They are much less forested and are wind-swept. Richards and Hedley* have shown that they really form part of an anti-

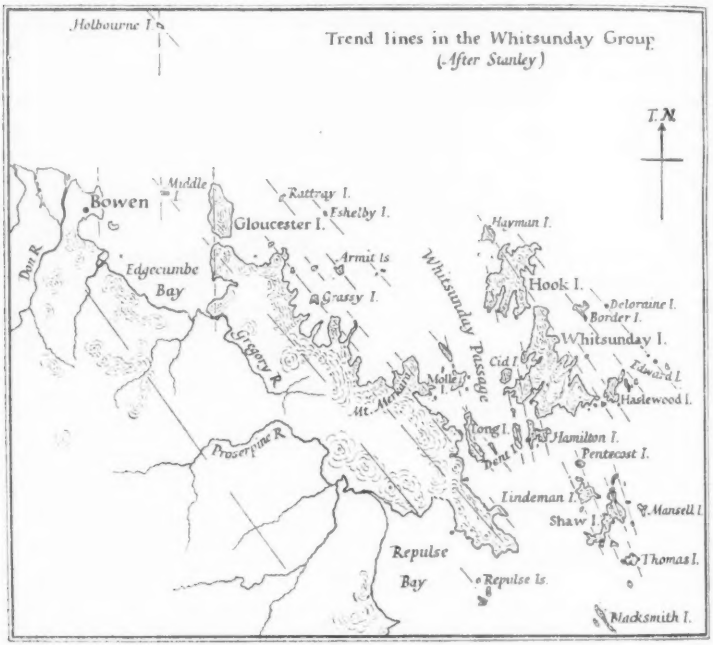


Fig. 3

clinal arch which has ruptured, and the rupturing has been responsible for the formation of Owens Channel, which runs in between the islands and nearly along the strike of the anticline. In every way they resemble closely the features on the adjacent mainland.

Many of these high islands are partly or wholly surrounded by fringing reefs. Doubtless these reefs have helped to protect the islands from the attack of the sea, and so have restricted the amount of cliffing.

A glance at the Admiralty Charts shows that many of these high islands are arranged in lines. It is by no means always safe to conclude that the islands are on a common trend or strike line, or that they once formed part of a con-

*Reps. Gt. Barrier Reef Comm., vol. 1, 1925, pp. 1–28.

tinuous ridge. But this is so in some cases, and has been demonstrated by Stanley and Jardine in the Whitsunday and Keppel Bay areas respectively. Of the Whitsunday Group Stanley concludes:*

"It has been seen that these (islands) can be grouped into units which are arranged along definite trend lines sub-parallel to the general trend of the coast-line. In text Fig. 25A, the trend lines have been drawn (see Fig. 3 opposite). A study of this map shows that instead of being strictly parallel the trend lines converge, suggesting by their disposition the well-known diagrams of the outcrops on a level surface of plunging synclines and anticlines. It is interesting to recall in this connection that W. H. Bryan has drawn an important anticlinal axis of the closing Mesozoic folding [*i.e.* in the Whitsunday area, J.A.S.]. The scattered geological observations made by the writer appear to confirm this, but the steep limb of the Whitsunday anticline faces east, which is unusual.

Again, the trend lines, instead of being continuous, are interrupted by breaks and gaps."

Jardine† also finds evidence for very similar trend lines in the Keppel Bay Islands, and the North Barnard Islands probably form another such line, and they continue the line of Double Point, a bold headland on the mainland coast. Thus, in reviewing the known and surmised tectonic lines of the adjacent mainland, these island festoons will be seen to fit into a general scheme.

It may be remarked here that a study of the high or continental islands really resolves itself into pure geology and tectonics. Many varieties of rocks occur, and any detailed study is the province of the petrologist. But the physiographer finds much of interest in the sculpture of these islands, and by observations of their drowned valleys now partially silted up, their benches, and their cliffs, he finds much direct and invaluable evidence of former changes of level. A study of these high islands reveals beyond the shadow of a doubt that they are portions of the mainland severed by submergence.

4. (*b*) *Sand Cays and Low Wooded Islands*

The low islands of the Barrier Reef area fall into two main groups: the one includes all the simple cays which are usually found on or near the outer Barrier, the other the more complex cays, or low wooded islands. This second group is practically confined to the area enclosed between the Barrier and the mainland coast. It will be convenient to treat these two groups separately, and by so doing slight variations in each may be noted.

Sand Cays

The simple cays are nothing more than a mass of coral sand piled up on a reef. The shape and size of these cays can best be seen from the maps reproduced (Fig. 4). They naturally vary in size, but 300 yards is a fairly good average for their larger diameters, and 150 to 200 for their shorter diameters. Their height is small, usually not more than 4 or 5 feet above high water springs. Many are lower. There is really no true separation between these sand cays proper and sand banks which are awash at high water. The latter have just not grown sufficiently to deserve the name "cay."

Such obviously unstable structures as these naturally vary much in shape

**Ibid.*, vol. 2, 1928, pp. 1–51.

†Reps. Gt. Barrier Reef Comm., vol. 1, 1925, pp. 73–110.

from time to time. A set of large waves coming in from any one direction will easily remould the entire cay. It is known how rapidly they can move. Lieut. Taylor of H.M.S. *Herald*, contributed a note* on the movement of Beaver Cay and on the unnamed cay 2 miles east of Beaver Cay. This note is particularly interesting in that Lieut. Taylor was at that time (1923) on H.M.S. *Fantome*, which was surveying the area. A mark was placed in the centre of

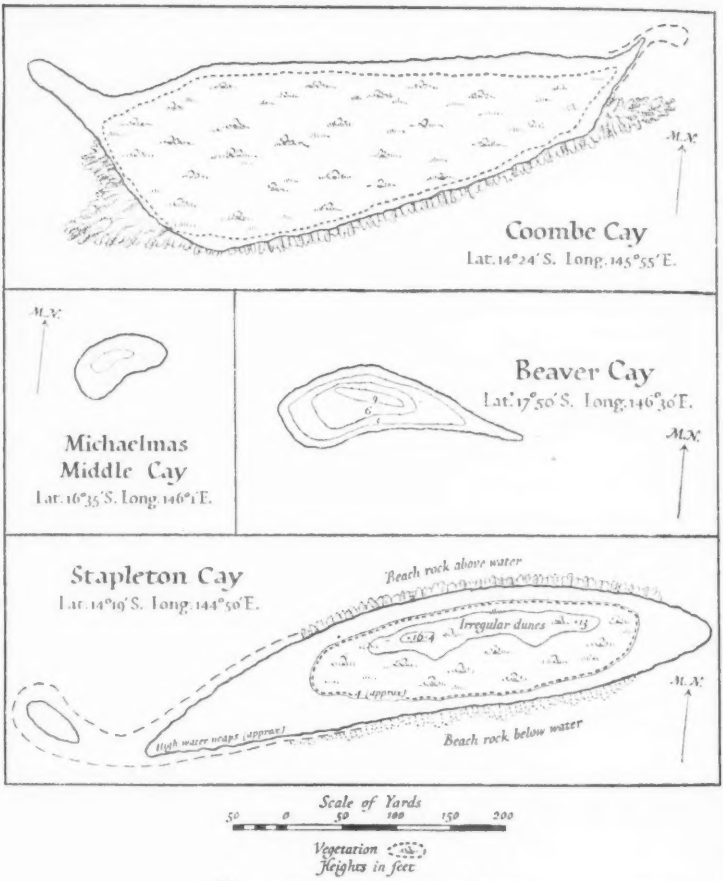


Fig. 4. Orientation of sand cays

Beaver Cay in 1921. This mark was out of place in 1922. In 1923 it was desired to put up another mark within 10 yards of the 1922 mark. No difficulty was experienced in this, but having fixed the mark the *Fantome* proceeded to Cairns for a fortnight. This period was marked by a strong north-

Queensland Geog. J., vol. 39, p. 38 (Contribution No. 2, Reps. Gt. Barrier Reef Comm.).

west wind. The mark was down on the return of the *Fantome*. Later work enabled Lieut. Taylor to prove a bodily forward movement of about 100 yards of the whole cay.

These simple cays are sometimes well covered by vegetation. Once vegetation has obtained a hold on the loose sand and has spread over it, the cay becomes a little more stable. Another factor, of which more will be said later, is the formation of beach rock round these cays. This rock must naturally have a very stabilizing influence. But an interesting fact emerges here. In all, we visited ten of these simple cays, including those with vegetation and those without. In no case did we find one in which there was beach rock and no vegetation. There seems to be no real connection between these two features, but in so far as stability is concerned it is an important point. I am unable to say if cays north of Flinders Islands disprove this statement: it certainly holds for those visited by us.*

All these cays are flat-topped for the most part. The sand may be slightly ridged round the exterior, and often the upper part of the sand was "twisted" with respect to the main axis of the cay. This twisting, which is to be expected, is due, almost certainly, to the particular waves playing on the cay when visited. Waves from other directions would soon alter the arrangement.

In so far as form and profiles are concerned there is no essential difference between cays with and cays without vegetation. But usually the covered cays are considerably larger and higher. This is due, in part, to a certain stabilization which a plant covering gives, and perhaps more to a spread of such plant covering which in turn traps the sand carried by the wind and so increases the height and area of the cay. Grasses and creeping plants are probably most effective in this respect. Where the vegetation, as at North Reef in the Bunker Group, is mainly of shrubs, this trapping does not work so effectively. Michaelmas Cay is a particularly good example of a cay covered with low grassy vegetation. Such cays are generally the haunt of numerous sea-birds. Farther north, Stapledon Island and Mackay Cay are other cases. These cays are usually higher and steeper than the uncovered cays. Very often the sea has cut minor sand bluffs all round them. In all cays that we visited very similar features were found.

Of greater interest with respect to their origin is the position of the cays on the reefs on which they stand, and their shape. In all cases we found they were situated near the western or north-western end or lee side of a reef patch.† Further, the longer axes of the cays nearly always ran from a point rather to the north of east to a point to the south of west. In other words, the major axes are transverse to the south-east trades, the prevalent winds in this area. Very often the cays are prolonged into two spit-like projections which

*Prof. E. W. Skeats in the course of conversation has made the following suggestion: "Is it possible that the decay of vegetation and the formation of vegetable acids assists solution and precipitation of $CaCO_3$ to form cement for beach rock?" Skeats noted this possibility when visiting the Capricorn group, where beach rock did not occur all round an island, but where there seemed to be evidence of drainage from the interior part covered with vegetation towards the coast. My own views concur with this at least in part. The whole question is worthy of more attention.

†Cf. Hedley, *Proc. Linn. Soc. N.S.W.* (Mast Head Island), vol. 31, 1906, pp. 453–479; and Jukes, 'Voyage of the *Fly*,' 1847, vol. 1, pp. 4–12.

may curl slightly back towards the south-east. The position of the cay and the orientation of its major axis seem to throw considerable light on its origin.

The coral sand of which all cays are built is clearly a detrital product due to the erosion of the reefs on which they stand. The main destructive work on these reefs is due to the south-east winds and waves. The material produced in this way is driven across the reef flat, but is not all carried right across. On the lee side of such a flat another factor comes in. The waves from the south-east wrap round the cay, and on the lee side the meeting of the two sets of waves coming round from the south-east is instrumental in stopping the travel of material, which is consequently piled up in the form of a cay. An examination of the charts of places not seen by us seems to suggest that this rule is generally applicable throughout the Barrier. Furthermore, the rule holds no matter what may be the shape of the reef on which the cay stands. Hedley and Taylor* have suggested that a reef grows from a nucleus into a crescentic shape, assuming the nucleus to lie athwart the Trades. This may be true of some reefs, but there are many exceptions. It seems, however, to have little if any bearing on the present matter. The growth and form of a cay are almost entirely independent of the reef on which the cay stands. Again, this rule will be found to apply very largely in the case of the low wooded islands.

It would be of great interest to examine more cays in detail and to note how far vegetation and beach rock do or do not occur together. Probably the sand cays are very recent structures, and a mere matter of time may be sufficient to explain the absence of beach rock. On the other hand, it might be worth while considering whether vegetation has any influence on the formation of beach rock.

Some cays may attain a considerable size, as for example, Green Island off Cairns. In fact, cays of this type resemble more closely the cay proper of a low wooded island. There is, then, every transition between the sandbank awash at high water and the relatively elaborate island such as Green Island. This difference in degree seems to be accounted for mainly in two ways—age and exposure. No direct evidence other than size and the stage to which vegetation and beach rock are developed suggests itself for determining the age of a cay, but it is a fact that the simplest cays are often in the more exposed places. This suggests that in many cases storms and other factors have prevented the cay from attaining any size, and, even more, have given such a cay a chequered career. It must be a matter of pure luck that a sandbank evolves into a cay: the transition stages must often be long, and the embryo cay is doubtless often washed away and growth has to begin all over again. Where, however, there is more shelter, growth may be more or less continuous and a fully developed cay may result.†

Low Wooded Islands

The low wooded islands are very much more complex and offer some very interesting physiographical problems. In nearly all cases there are two quite

**Aust. Ass. Adv. Sci.*, 1907, Sect. C. See also Hedley, *Am. J. Sci.*, Series 5, vol. 11, 1926, pp. 187–193.

†The movements of Beaver Cay have already been mentioned. It may be of interest here to note that Cook used to find turtle on a cay which probably stood on Turtle

distinct islets. The one is a sand cay to all intents and purposes similar to those already described. The other is almost always a mangrove-shingle island. The term "low wooded island" has come into general use on the Admiralty Charts, but it will be well to distinguish between the two different islets which go to make up a low wooded island. The one we may call the

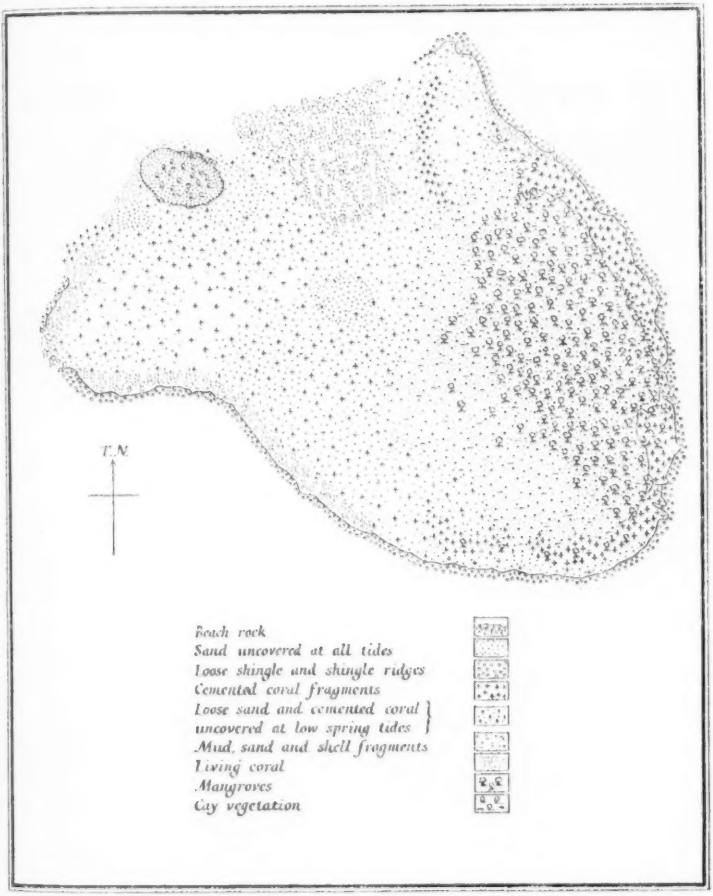


Fig. 5. Sketch-map of Low Islands based on a plane-table sketch by E. C. Marchant

Reef, an inner reef patch off the mouth of the Endeavour River. No such cay now exists, and we may probably assume that it has been washed away. There is no need to invoke any vertical movement to account for its disappearance. [See Tenison-Woods, *Proc. Linn. N.S.W.*, 1880–1881.] Again we find that certain cays marked on the charts now no longer exist, whilst in other cases new cays seem to have arisen, *e.g.* Eddy Cay near Beaver Cay could not be found.

sand cay, the other the mangrove-shingle cay. In most cases the two occur together on the same reef, but at Hope Islands, for example, the sand cay is on one reef and the mangrove-shingle cay on another. The two reefs are separated by a narrow and relatively deep lane of water. Nevertheless we may regard the two as an entity.

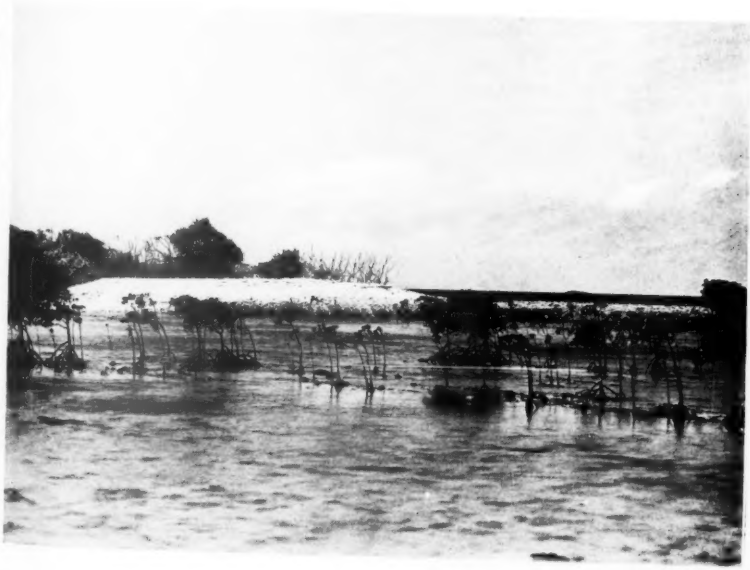
Before entering into a general discussion on the question of the formation of these curious islands, it will be well to describe one in some little detail. Low Islands—the headquarters of the main party of the Barrier Reef Expedition—will do well for such a purpose. The physiographical sketch-map made by E. C. Marchant, will make the following points clearer. To the north-west of the reef flat is the sand cay. On it stand the lighthouse, keepers' houses, and the huts of the expedition. It is in every way a counterpart of a normal simple cay. It is oval in shape and partly covered by vegetation, which includes coconut palms. These latter are, of course, not indigenous. Apart from this, however, the vegetation is normal and includes such common genera as *Tournefortia*, *Scaevola*, *Casuarina* and *Ipomoea*. The island is low and flat, and around its shores there is a good deal of beach rock. The beach rock here, and on all such cays, is simply lithified beach sands, and must not be confused with the coral conglomerates, etc., found on the mangrove-shingle cays. The cay has been built up rather higher than the uncovered cays by wind-blown sand caught by the vegetation. The longer axis is about 720 feet long, the shorter about 400 feet, and the perimeter about 1850 feet. The cay is composed wholly of sands which are of coral origin, and which clearly were worn from the reef on which it stands. The way in which it was formed is the same as that described on p. 250.

On the weather side of this simple cay, and separated from it by the pseudo-lagoon is the mangrove-shingle cay. These are curious and interesting structures. Normally there is only one such, but in Three Isles, for example, there are two of these mangrove-shingle cays. This, however, is really the exception which proves the rule. In all of them we find much the same features. To windward there is the slope of the coral reef down to deeper water. Just inwards from the summit of this occurs a ridge of coral shingle. This ridge is normally flat and slopes very gently seaward, but has a steeper landward slope. It is not by any means necessarily continuous around the outer side of the island, but occurs in patches. Within it at high tide is a shallow channel of calm water. We may call this the moat. Running inwards from this outer shingle ridge there is often a series of smaller ridges. These are narrow and flat and usually run at right angles to the main ridge. Sometimes they terminate in a bulbous end. Beyond ascribing these ridges to wave action, it is very difficult to see exactly how they are formed. In some ways they are reminiscent of shingle fans such as are found on the sheltered side of such ridges as the Chesil Beach or Blakeney Point. But their narrowness and length point to a somewhat different origin, which is not at all clear. Undoubtedly some are simple shingle fans, but the long narrow tongue-like projections are more difficult to explain.

These ridges usually rest on a platform of old coral shingle which is frequently solidified into a shingle conglomerate. This conglomerate often forms a very rough pavement which surrounds much of the outer part of the

Phot. M.A.S.

4. Green Island near Cairns



Phot. M.A.S.

5. Hope Islands: mangrove-shingle cay

Phot. J.A.S.

6. Shingle fan, Low Islands

Phot. M.A.S.

7. Low Islands from balcony of lighthouse. Huts of expedition in foreground; pseudo-lagoon in middle distance; mangrove-shingle cay in background

cay. The sea has often eroded* it to some extent, leaving jagged and picturesque features. If uplift has occurred, these features are intensified. More often than not this conglomerate shows vestiges of its origin as a series of layers. The separate beds are often truncated and the basset edges rise up. The dip of these beds is interesting. In nearly every case we examined the dip was variable, but very often landward. This must mean that considerable changes have taken place in the cays. In the normal case, one would expect

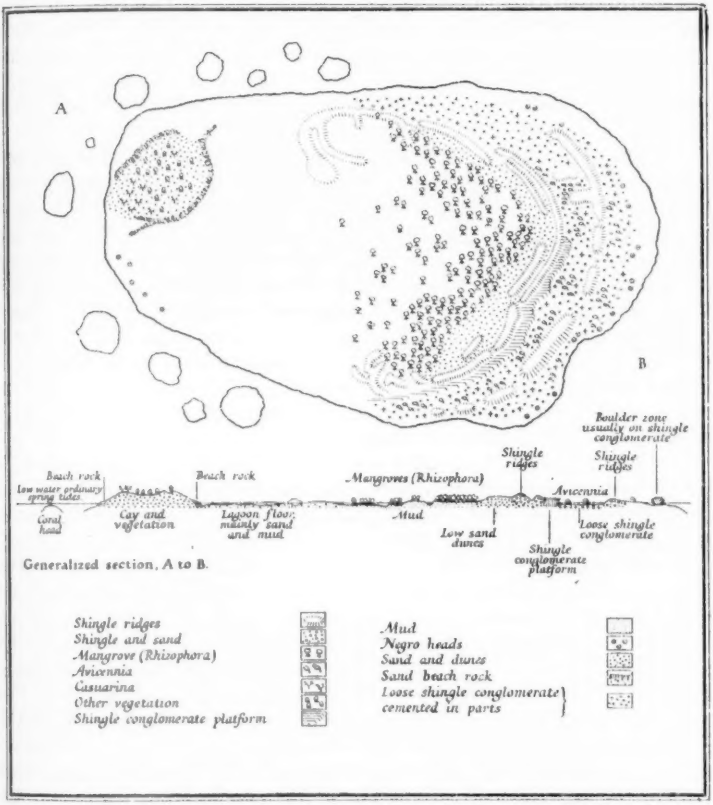


Fig. 6. Diagrammatic representation of a low wooded island

the dip to be seawards. These conglomerates are, after all, only lithified shingle beaches or shingle spits. Hence, we should expect to find either a seaward dip or a dip in either direction. Where, then, only a landward dip is found, it must be assumed that the rest of the spit or a ridge of shingle formerly existed to windward of the present outcrop. This is to be expected, as the weather side of any of these cays is subject to a good deal of erosion, and a step-by-step pushing back of such ridges is not at all unlikely.

*This erosion is still going on.

On the inside of this conglomerate platform one normally finds a series, by no means continuous, of modern shingle ridges. These are often very steep and are composed, for the most part, of new and clean coral shingle. They may have a covering of sand-dunes.* Inside these ridges is the mangrove belt. This feature is practically universal. The shingle when pushing back on to this mangrove often kills off some of the outer trees. There are several species of mangrove to be found in these belts, of which the commonest, at any rate on Low Isles, is *Rhizophora mucronata*. It is a point of considerable ecological interest that these particular mangroves are rare outside this belt. But on the shingle conglomerate pavement to windward there occurs another and smaller mangrove, *Avicennia* sp. This is usually accompanied by *Aegialitis*. It is extraordinary how closely this assemblage is faithfully reproduced on each low wooded island.

The mangrove belt proper is a gloomy region. It is intersected by channels and lagoons which sometimes dry out at low water, leaving an expanse of black mud. Here and there openings occur, and sometimes patches of dead mangrove which give to the place a very sinister appearance. As elsewhere, the mangroves here are partly producing their own mud, and their ramifying roots are trapping the silt brought in by the tides. There is no hard and fast line of separation between the shingle ridges and the mangrove swamp. Some of these ridges push right into the mangroves and may break off in a series of recurved termini. It may happen, as at Low Islands, that some of their ridges expand into a broadish and flat area at their ends. Such are often colonized by true land plants, and in the midst of a mangrove swamp it is no rare thing to meet a small patch of scrub vegetation.

It will be convenient at this point to recall the fact that the shingle on the outer edges of the cay is subject to movement under the action of winds and waves and currents. In the normal case, waves approaching from the south-east will help to drive the shingle backwards in two horn-like projections. This is well seen in Low Islands (see map). The continuation of this process often leads to long shingle spits being formed, and in Low Islands the small shingle cay to the east of the sand cay proper represents the terminus of one such spit. It is a particularly good example. The small shingle islets in the mangrove are doubtless similar in every way, but were formed at an earlier time.

Within the mangrove belt and the arms of the encroaching shingle is the pseudo-lagoon. It is not an atoll lagoon in any sense of the word, and following Hedley and Taylor,† we will call it a "pseudo-lagoon." This lagoon is shallow and may nearly dry out at low springs. Its floor near the mangroves is largely mud and sand, and, in a general way, it may be said that the quantity of sand and coarser materials increases as one goes away from the mangroves. This is due to the spread of mangrove mud, etc., over the coarser materials. In the deeper parts it is often coral covered, and very beautiful coral pools often exist in it. Scattered over the bottom are many clam shells—*Tridacna* and *Hippopus*. The mangroves are rapidly colonizing these lagoons, and at high water the advancing line of vegetation presents a very striking picture.

*These dunes are absent at Low Isles.

†*Reps. Aust. Ass. Adv. Sci.*, Sect. C, 1907.

First, after leaving the main belt of mangroves, we find many thick isolated clumps or lines of trees. These begin to thin out and give place to single well-grown trees. These, again, pass into smaller trees and saplings which stand up just above water-level or may even be completely submerged at high water.

A feature which occurs in many of these islands is a belt of sand or sand and shingle ridges between the mangroves and the outer shingle ridges referred to above. These are ordinary ridges piled up by the waves. In some cases, doubtless, they are hurricane beaches. Often they are raised in height by a slight capping of dunes. King Island near Cape Melville shows such ridges very well. One other important feature must be mentioned—the negro-heads. As noted elsewhere, negro-heads are found on most reefs, and on these particular islands they occur too. They sometimes occur on the windward side, but very often, as in Low Islands and Green Island, there is a belt to the north-west not far from the sand cay proper. As all these mangrove cays, so far as we know, occur within the Barrier proper, they are not exposed to the Pacific swell. Hence, as a general rule, these negro-heads do not attain a large size.

Such, then, are the main features which are to be found in most of these complex cays. Whilst, however, the repetition of this arrangement is common, it is not universal, and it will be well to describe one or two islands which show certain points of difference. It may be possible to distinguish a sub-type of these islands.

Certain members of the Turtle Group are examples of a kind of intermediate stage between the simple sand cay and the complex cay. The Turtles are not named separately and so I will describe the fourth member we visited of the group. This island is typical of many similar ones. The real point of difference between it and the complex cay is the absence of a lagoon between the mangrove-shingle cay and the sand cay proper. Such islands as these are usually small, and the main features—outer shingle ridge, moat, coral conglomerate platform, sand ridges, mangroves—are nearly always found in places similar to those in which they would occur on a complex cay. But here the mangrove-shingle cay is, as it were, closely wrapped round the sand cay. In this particular island the new shingle ridges have attained a beautiful stage of development, and at one point form a well-marked cuspate foreland. As in the complex cay, the vegetation is well contrasted, the mangroves forming a discontinuous but, where present, fairly dense belt around the true land flora of the cay proper.

Houghton Island, the second largest member of the Howick Group, is in some ways similar. The coral conglomerate platform here is exceptionally well developed, and, as noted elsewhere, may probably indicate uplift. Behind the platform are some good sand and shingle ridges which carry the normal cay vegetation. Behind this is a well-marked zone of beach rock and then the mangrove belt which in this case fringes all that part of the island facing Howick Island. One interesting feature deserves notice. At the western end of the island there is a remarkably clear example of an unconformity in the beach rock. The upper layers consist of horizontal beds of shingle conglomerate. The lower beds are of finer sands which show a fairly consistent dip to the north-west. Such unconformities are not uncommon, but this particular case is so clear as to deserve mention. It may be noted in

passing that, on this island, and on most other islands, there is a large amount of pumice cast up on the sand and shingle ridges.

In islands such as these, where the pseudo-lagoon is absent, we may suppose that the mangrove-shingle cay has been pushed back by the waves until it has encroached on and more or less surrounded the sand cay. On the other hand, many such islands are on small patches of reef, and it is possible to conceive of a very minor pseudo-lagoon at an early stage which rapidly disappeared in this way. Finally, on a small patch of reef, it is quite conceivable that sand cay and shingle cay evolved more or less simultaneously, and that a pseudo-lagoon never existed.

Perhaps the finest example of the normal case is that given by Three Isles. This group attracted the attention of Agassiz, from whose conclusions we differ.* Here the sand cay is well developed and is surrounded by beach rock, which is developed here better than in most islands. There are two mangrove-shingle cays in this case. There is no need to regard this as an exception in any way: the features in both are similar, but the more easterly is the bigger and in all ways better developed. The lagoon is almost completely enclosed, and the three islands are close together. Farther north a very similar case occurs. Ingram and Beanley Islands enclose a lagoon on a large reef. Ingram is the sand cay; the Beanley Islands are two mangrove-shingle cays.

It is unnecessary to describe any other such islands. Slight points of difference will be found, but the essential features are the same. The presence or absence of an enclosed or almost enclosed pseudo-lagoon is possibly a direct function of the size of the initial reef on which the cays stand. On a small reef the lagoon may soon be obliterated by the coalescing of the sand and mangrove cays, or it may never have existed. The origin of the sand cay is almost certainly the same in these islands as that of the simple sand cays on the Outer Barrier. The origin of the mangrove-shingle cay is a rather more difficult problem. It is probable that on the windward side of a reef a great deal of coarse shingle is formed by wave erosion, and that this is cast up as one or more ridges. Sooner or later relative stabilization of this shingle will occur. and so a barrier is formed behind which there is shallow water, or even no water at all at low tide. Mangrove seedlings carried hither by currents or other agencies arrive and take root, and eventually a mangrove belt is formed. The other features, negro-heads, further shingle ridges running round the island or running back from these encircling ridges, the moat and so on, are formed *pari passu* with the mangrove belt or subsequent to it. They are all clearly due to wave action. The question arises, is the sand cay older or of the same age as the mangrove-shingle cay? It is not possible, I think, to give an adequate answer to this. It seems, at first sight, that the sand cay should be the older. If our views on the building of the outer simple cays are correct, we must assume the sand cay of these complex islands precedes the mangrove

*Writing of Three Isles and Two Isles, Agassiz said: "Low Wooded Island, Three Isles and Two Isles are the only remnants of the numerous but widely separated islands which once existed between that Cape (Flattery) and the outer edge of the Barrier Reef, the others having been eroded and changed to reef flats and patches now existing to the eastward of these islands" (*Bull. Mus. Comp. Zoo. Harvard*, vol. 28, No. 4, 1898, p. 101).

cay. If it were not so, it is difficult to see how it could be formed once a mangrove belt has originated, because this must obstruct the travel of material over the reef. The reason why such mangrove cays do not occur, so far as our observations went, on the outer reefs, may be that here the waves are heavier and the shingle on the outer or windward side of such reefs must be in a state of constant movement, never stopping sufficiently long in any one position to allow the mangroves to establish themselves.

Before leaving the question of cays a word must be added about the vegetation. On some of the larger cays in the Turtle Group, or Two Isles, Ingram Island, etc., the vegetation is quite luxuriant. Large forest trees occur as well as the smaller and less conspicuous plants usually associated with these islands. The vegetation is often dense, and the undergrowth is penetrated with considerable difficulty. On the other hand, long open glades often occur. This latter type is very pleasing and calls to mind certain types of country at home. It is worth mentioning here that we found all stages of vegetation development. Many of the outer cays are quite bare: on Sudbury Cay we found seven small seedlings, one of *Ipomoea*(?) and six of *Sesuvium portulacastrum*. Mackay Reef was well covered in its higher parts by grasses and creeping plants, but only three or four species were collected. Much the same was found on Michaelmas, Stapledon and Coombe Islands—low grassy and shrubby vegetation, but many species. Then came the beginnings of tree vegetation, *Casuarina* and *Pandanus* being common. These give way to the elaborately covered islands, such as Ingram Island and some of the Turtle Group. A thorough ecological survey of these cays would be of very great value.

5. *The Negro-heads*

It is unnecessary to say much about negro-heads. They have been fully described by many writers, and, with the exception of Agassiz, all are agreed that they are masses of coral cast up on to the reef flats by waves. Opportunities occurred of seeing many groups of these coral blocks, and full agreement with the suggestions of Hedley and Taylor* resulted. The fact that these masses occur on the windward edges of reefs and also on the north-western sides, from which direction heavy weather often comes, leaves little doubt as to their origin. Without question they are the products of wave action and merely represent the heavier material cast up. As a rule they are now firmly cemented to the foundation on which they stand. Hedley and Taylor pointed out how mirage effects cause them to appear to stand up like gigantic monoliths. This effect is very disconcerting. A visit to a zone of these negro-heads often is very disappointing: the blocks are then seen to be quite ordinary-sized masses. This same mirage effect is seen on islands as well. Small islands often appear to be lifted up above the water. This effect was best seen in the Family Group.

**Reps. Aust. Assn. Adv. Sci.*, Sect. C, 1907.

(*To be continued*)

METEOROLOGY IN POLAR REGIONS: *A paper read at the Afternoon Meeting of the Society on 6 May 1929, by*

DR. G. C. SIMPSON, C.B., F.R.S.

WHEN I received a request from your Research Committee to open a discussion on the importance of climatic stations in polar regions I was glad to accept the invitation for two reasons.

In the first place, the attainment of both poles has removed the impelling force which directly or indirectly has been the cause of most of the scientific work done in the past in polar regions. A great deal of scientific work has been achieved on polar expeditions; but, regret it how we may, science has nearly always been a secondary consideration, a by-product, as it were, of the search for the pole. If scientific work is to continue in polar regions it must now be for its own sake, and that is the first reason which made me welcome an opportunity to survey the position so far as meteorology is concerned.

My second reason is connected with the strong wish expressed in many quarters that the jubilee of the great Polar Year of 1882–3 should be celebrated in an appropriate manner, probably by a repetition of similar international cooperation in polar research. You may remember that as the outcome of the energy and enthusiasm of Dr. Neumayer of the Deutsche Seewarte, and Lieut. Karl Weyprecht of the Austrian Navy, no fewer than twelve nations arranged expeditions in 1882–3 to polar or sub-polar regions—twelve expeditions in the northern hemisphere and two in the southern hemisphere. The results were extremely valuable, especially in connection with meteorology and terrestrial magnetism. If a repetition is to take place in 1932 we must justify the expense and draw up plans: hence the need for consideration now.

For the purposes of our discussion I will lay down three propositions: 1st, our knowledge of polar meteorology is such that little further advance can be made by spasmodic meteorological observations; 2nd, we need observations taken simultaneously in all parts of the polar regions, so that the actual conditions existing at any one time over the whole polar region can be studied in detail; 3rd, we need observations at a few representative positions which will give unbroken records extending over many years. I will now develop the ideas which lie behind these three propositions.

When I say that our knowledge of polar meteorology is such that little further advance can be made by spasmodic meteorological observations I do not wish to imply that we know all that there is to be known about the atmospheric conditions in polar regions, and that nothing at all can be learnt from observations made over short periods at widely different places. I can probably make my position clearer by taking an example. As the result of all the past observations of wind and pressure made within the Arctic circle we have a fairly good idea of the general wind and pressure distribution over the Arctic as a whole. If observations of wind and pressure were now made—say for six months at a single place—which did not fit in with our scheme, we should be very reluctant to change our ideas; we should be much more inclined to say that the new observations were not typical of normal conditions or that they had only local significance. The variations from normal in different years, or even from place to place in the same year, are so large that observa-

tions of this nature add little to the sum total of our knowledge. When the meteorological conditions of an entirely new area are being investigated the first few observations are of very great importance, but as subsequent observations are collected the importance of individual observations decrease in proportion to the amount of information already gained. We have certainly reached the position in the Arctic when further observations of the old climatic elements, such as pressure, temperature, wind, cloud, etc., have lost the exceptional value which they had when polar exploration first commenced, or even which they had thirty years ago.

In the Antarctic the same is true for certain regions, for example the Ross Sea area, the Weddell Sea, and Graham's Land quadrant; but there are still large regions in the Antarctic about which we know so little that every observation would be of importance. These regions are however difficult to reach, and so little is known about them that meteorology would be only one factor out of many which would demand their exploration.

My second proposition is that we need observations taken simultaneously in all parts of the polar regions. The greatest advance which has been made in meteorology in recent years is the development of the dynamics of the atmosphere. The interplay between masses of air of tropical and polar origin has been shown to be the prime factor in the genesis and development of cyclonic depressions and the source of the energy of the winds associated with them. The advance has been partly mathematical; but the study of synoptic charts and the investigation of the upper atmosphere have been the touchstones by which the progress has been tested. Thanks to the rapid development of the great national meteorological services and the cooperation of ships at sea, it is now possible to plot synoptic charts for the greater part of the northern hemisphere, north of latitude 40°, several times a day; but in these charts there is a great blank from 20°, more or less around the north pole. It is the dream of every meteorologist that this blank should be filled up. There is, however, no hope of this being accomplished on a permanent basis for many years to come. But if our network of stations could be pushed northwards during one or two years and observations taken at the standard hours for which synoptic charts are drawn, information would be obtained which would be of inestimable value both for theoretical and practical meteorology. In theoretical meteorology, the chief use made of the additional information would be to follow the changes in temperature and humidity which the masses of air undergo while they are in Arctic regions, especially during the winter, for it is these changes which transform tropical into polar air. In practical meteorology the chief advantage would be in extending the area of the synoptic charts used in forecasting, but this would require the immediate transmission of the observations by wireless telegraphy.

Thirty years ago meteorologists thought that they knew all about the general circulation of the atmosphere, and every old text-book of meteorology contains a diagram showing the paths of the main air currents between the equator and the poles. Now we are much more humble, and no modern meteorologist is prepared to draw such a diagram. We now know that the problem of the general circulation of the atmosphere cannot be solved by

work in the study. The only way is to go out into the field and observe the motion of the air in all layers of the atmosphere. Even then the conditions are so variable and so disturbed by passing weather conditions that individual observations cannot be interpreted with certainty. This is essentially a problem to be solved by simultaneous observations at a number of stations, and there is no doubt that valuable information could be obtained regarding the general circulation of the atmosphere in polar regions, if a number of stations made daily observations by means of pilot balloons for a complete year. It would then be possible to plot the air currents over the whole region and so follow the paths of the air under both normal and disturbed conditions.

Long-range weather forecasting is a fascinating scientific problem; but its economic importance is so great that it overshadows all other meteorological problems in many countries. The only method of attack on this problem which has shown any hope of success up to the present is that of correlation. This method, however, is only possible when there are long series of homogeneous data extending over many years available for correlation. Such data do not exist for any stations typical of the general conditions in either the Arctic or Antarctic, and it is highly desirable that one or two permanent first-class meteorological stations should be established in the Arctic and the Antarctic. It is not necessary that they should be placed near to the poles, but sites could be found which could easily be reached each year by sea or land transport, and which would be fairly satisfactory from the meteorological point of view. I should, however, like to say a word of warning. One frequently sees it stated in the public press that the polar regions hold the key to seasonal forecasting. That the conditions in polar regions are of importance no one will deny; but that polar conditions have a predominating influence on the weather of the world is open to serious question. When all is said and done the poles play a very passive part in the general circulation of the atmosphere, and if large changes are imposed on that circulation it is much more likely to be by changes in the hot area of the Earth's surface than in the cold areas. I think that Mr. Hunt, the head of the Australian meteorological service, is probably right when he says that so far as seasonal forecasting is concerned the great deserts are the places to investigate rather than the poles. That, however, is no reason for neglecting the polar regions, and the most reasonable line to take is to establish permanent meteorological stations in all parts of the world, so that no appreciable area of the Earth's surface goes unrepresented in our calculations.

Before going further I should like to say a few words about the project of a scientific expedition to the Arctic by means of an airship. Most of my hearers probably know of the plans of the international organization called Aeroarctic, formed for that purpose. Amongst the items of its programme which have been discussed the following may be mentioned:

(*a*) Flights of an airship across the Arctic, during which observations will be made on meteorology, atmospheric electricity, and terrestrial magnetism. Also the airship will, as conditions offer, descend to the water and carry out hydrographic observations, including sounding, water samples, water temperatures, and the investigation of marine life.

(*b*) The airship will be used for establishing at points on land, inaccessible by ordinary means of transport, meteorological and wireless stations. The personnel to be changed and provisions supplied by periodic visits of the airship.

(*c*) Similar stations to be established on floating ice in the innermost area of the Arctic.

The last of these proposals is definitely postponed for the present; but it is hoped to be able to carry out the two former in the immediate future. Arrangements have already been made for the new Zeppelin to make an Arctic voyage next year, for which an ambitious scientific programme has been drawn up.

From the very first I have refused to be associated with this undertaking, and I will shortly give my reasons.

In the first place, I consider that airships have not yet proved that they are suitable for such journeys. Until it has been shown that airships can be navigated with safety for long periods and in difficult weather I see no justification in sending them to regions where they cannot receive outside help if in difficulties. We have recently had experience of the disturbance which results when an airship gets into difficulties in Arctic regions. The whole world is upset. Relief expeditions have to be rapidly organized, and these relief expeditions themselves entail great risk to those who take part in them. The loss of Amundsen in the Arctic and of Keith Anderson in Australia on relief expeditions will be fresh in the minds of all of you. It will be said that until airships make journeys in the Arctic we shall never have transarctic airways. My reply is that it will be time to consider transarctic airways when we have regular airways over those parts of the world where difficulties do not necessarily lead to disaster.

My second reason for objecting to the proposed use of airships is that the scientific observations which can be made from airships are of little practical value. A few observations of air temperature at say 3000 feet are useless unless we have the temperatures at the ground at the same time, and the airship cannot provide these. I know of no measurements of atmospheric electricity which can be made from airships which would be worth going to any risk at all to obtain, and I think the same can be said of measurements of terrestrial magnetism.

It seems to me to be foolish to talk about hydrographic surveys being carried out from an airship in the Arctic, before we know whether it is possible to carry out hydrographic observation from an airship in any circumstances.

The idea of depending on airships to provision detached parties of men, whether on land or on floating ice, with our present experience of airships, appears to me to be simply courting disaster.

These, in short, are my reasons for refusing to take any part in the activities of Aeroarctic. They are, however, only my own personal opinions, and they do not prevent me wishing all success to those who—probably because they are both bolder and wiser than I am—have undertaken this great project.

In his letter asking me to open this discussion Mr. Hinks posed the question: "If one had half a million a year to spend on meteorology, would you spend it on maintaining a girdle of polar stations?" This appears to be a simple straightforward question, but, like many other simple questions, no simple

answer can be given. Two things, however, can be said at once: first, I should not spend it all on polar stations; secondly, I should certainly spend some of it on polar stations. Instead of attempting to give any more definite answer to Mr. Hinks's question, I should like to outline the plan for the future development of meteorology in polar regions which I should follow if I had command of reasonable funds.

In the first place, I should establish two first-class geophysical observatories in the Antarctic, one in the Ross Sea area and another in the Weddell Sea area. I should also establish two similar observatories in the Arctic, one to the north of Canada and one to the north of Siberia. These stations would be in such situations that they could be visited without danger every year. I should then slowly and methodically extend northwards the ordinary network of telegraphic reporting stations as opportunity offered. I should establish no new settlements for this purpose, but should make use of trading posts and police posts, providing them with the necessary wireless apparatus for sending their messages. I believe that this policy is already being followed in Canada and Russia, and has long been followed by Norway in Spitsbergen and by Denmark in Greenland.

The position is not quite the same in the Antarctic. The great expanse of the Southern Ocean will always cause a break between the network of stations in the southern continents and any network which could be established on the Antarctic Continent. This break is so wide that it is very doubtful whether it would be possible to construct synoptic charts which would connect the two networks. Personally, therefore, I should not advocate the immediate establishment of further stations in the Antarctic beyond the two geophysical observatories already referred to.

Finally, I would like to say a few words about the programme for the proposed Second Polar Year in 1932. My first idea, when the suggestion to celebrate the jubilee of 1882 was made to me, was to direct all our energies to getting international cooperation in the establishment of the four geophysical observatories which I have already suggested. I am afraid, however, that there would be difficulties in organizing this kind of cooperation in the present state of the world. So far as international opinion has been expressed up to the present, it would appear to be tending towards the establishment for twelve months of a large number of quite small observing posts where observations of terrestrial magnetism, including aurora, and meteorology, including upper-air observations, would be regularly made. I am drawn towards this plan, because my own experience in Karasjok, in Lapland, during 1904–5, showed what valuable results can be obtained at little expense, by trained physicists setting up their observing stations in remote inhabited spots.

If for one year the most northerly inhabited regions could receive parties of two or three men who had just finished their university studies, a very valuable series of observations would be obtained. The chief expense would be the cost of the instruments, and the only difficulty that of transport to some of the more distant posts. It is surprising what young men will put up with, and the whole experience would be so attractive to young physicists that I am sure that there would be no dearth of suitable volunteers.

DISCUSSION

Before the paper the PRESIDENT (Colonel Sir CHARLES CLOSE) said: Dr. Simpson is the head of the Meteorological Office of the Air Ministry and has had a very great experience of matters about which he is going to talk to us this afternoon, in Lapland, in India, and in the Antarctic during 1910–11. With those credentials you may be sure we shall hear a great deal of value on a subject very much on the tapis nowadays.

Dr. Simpson then read the paper printed above, and a discussion followed.

The PRESIDENT: We are fortunate to-day in having Monsieur de Margerie with us. We should like to hear a few words from him.

M. EMM. DE MARGERIE: I thank you for your courtesy in asking me to offer some remarks; but I am not really qualified to speak with regard to Meteorology.

Nevertheless, I was struck by the wisdom and sagacity of Dr. Simpson's paper, particularly by his intimation that we must not lose sight of the possibilities of airships in scientific investigations, especially in the Antarctic. Perhaps Dr. Simpson will be interested to know that the great Swedish explorer, Sven Hedin, has just started, with a strong band of assistants, a systematic series of meteorological observations all across Central Asia, from Russian Turkistan to Kan-su. Presumably the result of that survey will be most useful to the knowledge of the conditions which control air circulation throughout the Northern Hemisphere.

In any case we shall be pleased to see the plan sketched by Dr. Simpson realized two or three years hence, in celebration of the Jubilee of the Polar year.

Prof. CHAPMAN: I should like to say something with regard to the proposal to explore the Polar regions further, from the standpoint of terrestrial magnetism and aurorae. If such exploration is to be for scientific purposes, then I think those subjects well deserve attention. From that standpoint the Polar regions are of quite exceptional importance. If Mr. Hinks had put the question to me, similar to that he put to Dr. Simpson, "If I had half a million a year to spend on terrestrial magnetism and aurorae would I spend it on establishing a girdle of Polar stations?" my answer would have been "Yes"; and for this reason: In the Polar regions, near the zone where aurorae are most frequently seen, the transient magnetic variations, especially those observed during magnetic storms, are extremely highly differentiated. Within a few hundred kilometres the daily variation in the vertical force of the Earth's magnetism is changed in sign on the two sides of the auroral zone. In no other part of the Earth is there such a change in the properties of the Earth's field within so small a distance. But there is still a great deal that is not known about those changes near the auroral zone, and we know still less for the region within it. The radius of the auroral zone is about 23°, so that there is a spherical cap at each pole of the Earth, with a radius of 23°, within which we know too little of the magnetic variations, and but little of the actual values of the magnetic force. Even just outside the auroral zone, which does cross inhabited country at several points, there is much that is uncertain; hence at present, partly because of lack of observations, we have no satisfactory theory at all as to the cause of magnetic storms, phenomena which are of great interest and of some importance, not only in science, but also nowadays in commerce, seeing that magnetic storms have considerable influence on the propagation of wireless messages between the great inhabited countries of the world.

In 1902–3—that is twenty years after the Polar year—a great effort was made by a private individual, Birkeland, who established four magnetic stations in Norway, Spitsbergen, and two other points several hundred kilometres apart.

He published the results of his observations in two large volumes which are of extreme value for the study of these phenomena. But four stations are far too little when the phenomena are so highly differentiated within a small region. So that for my part I think it is extremely important for terrestrial magnetism to have a considerable number of stations as close together as possible for one year. I quite agree with Dr. Simpson as to the importance of having at least two first-rate geophysical observatories in the Southern Hemisphere. But while there should be some stations around both Polar caps, I think it is of importance to have a majority of them round one Pole, so that the phenomena there can be observed in much greater detail.

There is also another aspect of the matter. I have spoken mainly about the variations which the Earth's magnetic field undergoes, but a knowledge of actual values in Polar regions is likely in future years to be of importance. If aerial transport across the Polar regions is to go on, it will be necessary for us to have good magnetic maps of those regions, and also to keep those maps up to date by applying the secular variation; that means a good magnetic survey of the Polar regions, and also a few stations there permanently, so that the changes in the Earth's field may be followed and the maps brought up to date from time to time.

Sir GILBERT WALKER: My remarks this afternoon will be devoted to the third proposition which Dr. Simpson maintained,—the need of stations not persisting for a few months only but over a series of years. It is unnecessary for me to remind you of the knowledge which we have that seasonal weather over wide regions of the Earth's surface is interrelated. One of the most striking features in connection with that is the persistence of the character of seasons; if you have drought or coldness prevailing for one or two months it is likely to persist for a longer period. As far as I am aware nobody has ever satisfactorily explained this persistence, and one of the most promising places in which to look for it is the way in which ocean temperatures prove to be among the most important controls of weather on the earth.

Now, in studying the ocean it is obvious that the conditions in the Arctic and Antarctic must be of importance in connection with temperature, and as an illustration I would quote a fact which we found out about a fortnight ago: that the temperature measured in the Antarctic off Cape Horn controls the temperature at Cape Town a year later to a degree which you can represent, roughly, as 75 per cent. The amount of variation of temperature is very small, but this control is among the most complete that we know of; and it is obviously dependent upon the current of water which flows through Drake's Strait and eastwards to the south of Africa. You may ask, What is the importance of these relationships? As Dr. Simpson has hinted, not merely are they valuable in throwing light on the processes at work in the atmosphere, but they do assist us in forecasting seasonal relationships; and as that knowledge increases it will acquire commercial as well as scientific value.

Conditions in the North Atlantic may serve as an example. We have known for a long time that a strong circulation in the Atlantic means a warm winter in Northern Europe, and cold in the Labrador Straits; and for some time that a winter of this type brings cold to the Cape Verde Islands. Now we have lately stumbled on the fact that a strong circulation in the North Atlantic means scanty rainfall in the eastern half of the West Indies; the relationship is fairly close, and it is to be hoped it will in time be of use in forecasting. It is on those grounds that I would press for the establishment of a limited number of stations in the Arctic and Antarctic for a sufficient length of time to correlate their variations with those of weather in other parts of the world.

Dr. H. R. MILL: I have not much to say on this subject because, though my

interests have been very largely engaged in the Antarctic and, to a less extent, in the Arctic regions, I have no personal knowledge of them either as an explorer or resident, nor of the particular factors affecting their atmospheric and magnetic conditions. But I have paid attention to the history of exploration and to the work that has been done by the various expeditions since exploring began, and I thought at first that I might have a good deal to criticize in what Dr. Simpson was to say. But I find now that Dr. Simpson's wisdom, which Monsieur de Margerie with his accustomed acumen diagnosed at once, has avoided all the possible points of attachment for my criticism. He is even wise enough to guard his prudent cautions against rash experimentation by acknowledging that in future such methods may become practicable though they are undesirable at present. I thought when he began to speak of Aeroarctic that he might emulate a very wise physicist of one hundred years ago, Dr. Dionysius Lardner, who proved by careful reasoning the utter uselessness of experimenting with those new-fangled steam-vessels for crossing the Atlantic, because the consumption of coal required to propel a ship for 3000 miles was greater than the carrying capacity of any ship that could ever be constructed: therefore, as it was useless to try experiments with steam, we should go on improving sailing vessels. The enthusiasts went on with their efforts and proved Dr. Lardner wrong. Dr. Simpson allows that airships may possibly be built and handled so as to make trips over the Arctic with reasonable safety, and I for one believe that in this he is right, and that the air will become a highway for transport.

I have given, to a certain extent, support to the Aeroarctic scheme, but I did that because I feel that there are two ways of encouraging the progress of scientific research. One way is that of caution; not attempting, or helping, anything from which we do not see good reasons for expecting successful results. The other is that of encouraging enthusiasm and enterprise even if the chance of success is small. Of course, the enthusiastic and the cautious type of investigation are different: in fact, they can rarely if ever be combined in the same individual. A great deal can be done by enthusiasm, especially if the enthusiasts in question are not burdened with too much knowledge. In the search for truth a considerable ballast of ignorance is, in my opinion, often of service. Discoveries have been made before now by those who were too ignorant to know the enormous difficulty of the task on which they embarked but had enthusiasm enough to try experiments and carry them through unrestrained by wise counsels advising caution until such and such preliminary data could be obtained. So my feeling is that when there are people of sufficient enthusiasm to carry out bold enterprises the success of which seems doubtful, we should not discourage the attempt lest we retard discovery. A real enthusiast is helped by the opposition of people who know the risks, because it raises the pressure of his enthusiasm and enables him the better to overcome difficulties. When I see a man who is ready to go out into the Polar regions in any airship I will tell him that I would not go myself; that I think it is rash of him to go; but at the same time, like Dr. Simpson, I would wish success to his venture, and if I liked and trusted the man I would encourage him to do so. Of course it is absurd to say that great value can attach to sporadic observations of temperature or other meteorological elements or of magnetism, but it may be that certain exceptional phenomena may be caught and profitably studied in a particular area at a particular time. There is a good deal to be learnt from sporadic observations when we happen to hit upon such phenomena at the moment when they take place.

I have had to consider the enthusiasm of our American friend, Professor Hobbs, with regard to his glacial anticyclone, and though I think he has gone too far in his theory, I do believe that there may be more in the dynamic power

of cold producing condensation of air and a downward and outward flow from the Antarctic than perhaps Dr. Simpson with his greater knowledge and experience is inclined to accept. I should like to see as many circum-polar stations as possible established for the purpose not only of accumulating normal data but also of testing the theories of enthusiasts. I entirely agree with Dr. Simpson, however, in recognizing the necessary limitation of resources which will probably make two such stations in the Arctic and two in the Antarctic as much as it would be reasonable to contemplate. But those stations should certainly be established, if possible, in the Jubilee year of the previous circumpolar observations in 1882–83. If possible I should like to see more, but it needs some one with enthusiasm, like Neumayer and Weyprecht, to set the scheme going and enlist the aid of governments. Of course, it is not wise to tell the Governments of the South American, South African, and Australian States that observations in the Antarctic will be of economic benefit to the agriculture of their countries, because the probability is that such a line of action will lead to disappointment. At the same time, I think it is desirable to stress the importance of getting new and long-continued Antarctic observations from which in the future a more complete knowledge of the general circulation of the atmosphere will certainly be obtained, and that information must necessarily react on the practical applications of meteorology in forecasting the weather and longer fluctuations of climate also. Therefore, I sincerely hope that these observations in the Arctic and Antarctic will be organized and carried out in a manner no less complete than Dr. Simpson recommends.

Captain J. K. Davis: I am asked by Sir Douglas Mawson to express his very great regret that he is unable to be here this afternoon. He is, of course, naturally very much interested in the subject about which Dr. Simpson has been speaking to us, and but for the fact that he is leaving on Thursday for Australia he would have been here. He asked me to come and try to fill his place, which I am afraid I am quite unable to do, as I know nothing whatever about the science of meteorology; but as a seaman I naturally always expect the meteorologist to tell us what sort of weather we are going to have. I am, like all other seamen, under a very great debt to the meteorologist because our job at sea is made so much easier nowadays by the very complete meteorological data with which we are supplied. I could not help thinking as Dr. Mill was speaking that I possessed that " ballast of ignorance" to which he referred about this subject, and therefore it seems to me the very best thing I can do is to admit it and say no more. I am very pleased indeed to have had the opportunity of being present this afternoon.

Mr. David Brunt: I only wish to emphasize the importance of acquiring a deeper understanding of the general circulation of the atmosphere. That is the point which appeals to me most with regard to the formation of the circle of stations around the Poles. But I think there is one little point that we must not overlook: that if we spend a year or two in carrying out intensive observations in the Arctic and Antarctic we must be prepared also to carry out at the same time some rather intensive observations at home. Dr. Simpson outlined the proposal for two large stations near each Pole, where we should carry out observations of upper winds and of temperatures in the upper air. I do not think we shall gain much from this scheme unless at the same time we carry out in all countries where it is possible a series of observations of a similar nature. It is of interest to this Society to urge that we should endeavour to understand the general circulation of the atmosphere because every text-book of geography has given a perfectly complete but perfectly inaccurate picture of it. The most permanent features of the whole atmosphere are the sub-tropical anticyclone in each

hemisphere, but there is no explanation available at present even of these permanent systems. An explanation of these fundamental features of the general circulation will, I think, be forthcoming in time, though not immediately, if we have intensive observations in the Polar regions.

It is almost impossible to imagine that weather forecasting as such can be improved until the background of weather has, in the first place, been understood. Personally, I regard the relation between the weather and the general circulation as the relation between the dog and the man with whom he goes for a walk. We are trying to forecast which way the dog will go before knowing in which direction the master is going. When we have found out which way the master is going, then will be the time to begin guessing what the dog will do.

Dr. Simpson, apparently, had a very difficult question put to him as to how to spend half a million pounds on meteorology. As he did not feel called upon to answer it, I do not myself feel called upon to do so, but I would urge that if he is going to spend £100,000 of it in Polar observations of meteorology, then an equal amount has to be spent elsewhere, otherwise the observations in the Polar regions will be wasted.

The question of long-range forecasting which has been put before us by Sir Gilbert Walker is, after all, another way of looking at this problem of the general circulation, because, as I think Sir Gilbert Walker would agree, what we call the general circulation, which is the background of weather, is not the same from year to year. It is the differences from year to year which Sir Gilbert Walker is running to earth by evaluating his coefficients of correlation.

Admiral Sir WILLIAM GOODENOUGH: What I would like to know with regard to forecasting and the sort of general arrangement of the weather is, how much importance is placed on the more temperate zones, as to the origin of what makes the various weather, and how much on the Poles with regard to the temperatures of the water and the temperatures of the air? Those are the only questions I would ask.

Mr. L. C. W. BONACINA: I am constantly receiving questions of a climatic nature which tax my wits, so I have done a good deal of thinking about climatic problems. Connected with the Polar regions are two problems which it seems to me that such an institution as the Geophysical Institute suggested might very well tackle. There is the outstanding problem as to whether the snowfall would be sufficient around the Poles to survive the summer at sea-level. That is a problem upon which there are two opinions. I am rather inclined to think that it would not be, but I do not want to go into the subject much now. Nevertheless, it is a very important problem remaining to be settled because it will throw light upon a great many other matters. At the South Pole snow survives the summer because it rests on high plateau, at the North Pole because it floats on sea-ice. The phenomenon of the Antarctic Barrier is no argument in favour of a permanently snow-clad Antarctic Continent at sea-level, since the area is comparatively small in a very cold environment of high plateau on the one hand and sea-ice on the other, and it is, moreover, partially afloat.

I agree in the main with what Dr. Simpson says in reply to this note that it all depends on the distribution of land and sea; that if the Arctic Ocean were dry flat land the summer melting of the snow-sheet in Northern Siberia and Northern Canada would extend across the Pole, and that if Antarctica were planed down to sea-level the surrounding cold seas would tend to preserve snow in summer. But the critical factor involved is the amount of the snowfall. In the case of the hypothetical lowland Antarctic Continent the summer fall of snow or sleet would be of a monsoonal character, due to the influx of cold winds from the surrounding icy seas on to the sun-warmed land, and it would obviously

depend on a very delicate balance whether this snowfall would suffice to keep pace with melting under the summer sunshine.

Another point which Dr. Simpson's Institute, it seems to me, might keep a watch upon is what happens to the temperature when the sky clears during the summer months in the Polar regions, when the sun does not set. Of course, in tackling that question you would have to make allowances for any change in the air supply, but I think such observations as do exist are rather ambiguous. Sometimes the temperature falls, at other times it rises. Now if the temperature under certain atmospheric conditions falls when the sky clears during summer months it would throw considerable light on the origin of summer cold spells in the Arctic basin and Northern Hemisphere, because radiation to the sky in the Polar regions is theoretically the only source of cold weather remaining to the Northern Hemisphere at midsummer except, of course, air drainage from comparatively small plateaux like Greenland.

As to what Dr. Simpson said with regard to the mainspring of the circulation being in the hotter regions, I think that certainly is the case; but we must remember that there is likely to be a very pronounced reactionary response of the circulation in the Polar regions with corresponding variations in the position of the Polar front, etc.

I think, from the climatic point of view, it would be well worth establishing these stations.

Dr. G. C. SIMPSON: I shall naturally make a somewhat disjointed reply. As to what Monsieur Margerie said with regard to Sven Hedin's observations from the middle of Asia, it is really extremely interesting to see how one activity aids another. Sven Hedin's idea is, I believe, to establish a trans-Asiatic air route, and of course for this he must have a series of meteorological stations. As soon as these stations have been established the scientific results will become available for scientists who stay at home, and I am quite certain Sir Gilbert Walker will love to have fifty years' meteorological observations from the centre of Asia.

With regard to what Professor Chapman said, namely, that he would have used the whole of the half-million for establishing magnetic stations at the Pole —so would I if I had been a terrestrial magnetician. There is no question that for terrestrial magnetism the Pole is the thing to go for, because the phenomena of terrestrial magnetism are largely concentrated at the Poles. At all events, there is no question that the position is different in the two cases, because the magnetic poles do concentrate the magnetic conditions much more than the Poles concentrate meteorological conditions.

Sir Gilbert Walker agreed in general with my proposals, and I have nothing to remark about what he said except to say that I was very interested to hear about his new piece of work which shows such a good correlation between the temperature off Cape Horn and the temperature twelve months later at Cape Town. One cannot help feeling that if Sir Gilbert Walker continues his work, we shall soon know much more about weather relationship in different parts of the world. What he has done now in showing this relationship not only means a tremendous amount of work, but it is definite new knowledge.

Dr. Mill spoke on a point about which I agree entirely: He said that if we are too careful and simply say we will not go to the Arctic in airships, we shall never get anything done. That is perfectly true. I have often thought since I have had to take the responsibility of advising the Government of this country with regard to Aeroarctic, whether the chances of disaster are any greater at present with airships than they were with ships in the sailing days. I rather think that the risk was greater with the sailing ships. Therefore I agree with what Dr. Mill says. But there is an alternative. You see, it is not necessary to

send these airships into the Arctic this next year or the year afterwards. There is plenty of time. Really we are not sitting down and waiting for these few meteorological observations from the Arctic or from the Antarctic. Let us work out methods with the airships over lands where they can be got at if anything goes wrong instead of sending them to places where if anything happens the whole world is upset, and relief expeditions have to be sent out by many countries.

I cannot go into all that Dr. Mill said, although I would like to. He mentioned the cold downward outflow of air from the Antarctic which I think he said I probably should not agree with entirely. That is a very good example, to my mind, of the sort of problem which we have to solve at the present time with regard at least to the Antarctic.

Then Dr. Mill also said we ought not to promise the Governments of the surrounding countries that if they establish these Polar stations, we shall be able to solve all their problems. That is the one thing which I have been saying over and over again. I have written to the Australian Government on this question and to the South African Government, and said that we want the stations before we can answer such a question. We cannot promise that if we are given those stations we will be able to solve the problems, but we can say definitely that until we have got the stations we cannot answer the question one way or the other. That is the attitude I have always taken up, and I think it is not an unreasonable one.

Captain Brunt referred to the desirability of not putting one's attention too much into the Polar regions when making these observations, but that simultaneous observations should be made in other parts of the world. There is no doubt about that. I did not dwell on that aspect because I tried to get my paper within fifteen minutes. I may say that we have recently circularized practically all meteorological services in the world with regard to the proposed Polar year, asking them whether they agreed, and if so, what observations we should take. In the replies we are receiving quite enough advice from our colleagues to ensure that we do not put the whole of our eggs into one basket in the Polar regions.

Admiral Goodenough asked how much does the control of the weather depend on temperate regions as compared with polar regions. My answer to that question is, that it depends entirely on whether you want to lead a Polar expedition or not. If you do, you will be quite convinced, and probably conscientiously, that you will know nothing at all about the weather, and you will never be able to make a reasonable forecast, until you know all about Arctic or Antarctir weather. Speaking now as a meteorologist, all I can say is that the whole atmosphere is so keyed together that there is no one region which plays a predominating part. It is quite possible that if there is a change in the climate of the world some parts will show it more clearly than others, and, as I said in my paper, I personally feel that those changes will be indicated much more in tropical and desert regions, where you get the full effect of any variation in the solar radiation, than in the Polar regions, the conditions of which are nearly independent of the energy they receive from the sun directly.

I think Mr. Bonacina was trying to get at me as a result of a paper which I read elsewhere in which I put forward certain ideas. I do not think I can quite go into all the points he raised, but I would like to say one or two words about the first question he asked. It is really hardly suitable to this discussion, but it is rather an interesting problem. He asked, in effect, would there be any ice or snow on the area round at the Poles if the Earth were perfectly flat, and at sea-level. Before answering that I would like to say there is another problem of the

same nature which has worried me more, and that is if the Poles were on the middle of the ocean, in the middle of the Pacific, for instance, would you have a permanent ice-cap? You see, the sea would freeze in the winter quite certainly, but would not that ice every summer or all the time drift away steadily, so that it could never grow to sufficient thickness to be a permanent ice covering? That is the sort of problem that one would like to answer. I think there are two answers to Mr. Bonacina's question, which would be different according to the distribution of land and water. Now, I feel quite certain, and Captain Davis, I think, will bear me out, that the whole of the snow which falls at sea-level in the Antarctic remains there, except in a few places where the wind blows it away. If you levelled down the plateau I do not think there is any doubt that the Antarctic would remain snow-covered. That is because the water round the Polar continent keeps the temperature down in the summer so low that the ice itself is not melted. But if you filled in the north Polar Sea with land, I think—it is only guessing—from what I know about these things that it would clear of snow every summer, because the big land masses all round in the temperate regions would warm up the air, and this warm air would be carried into the Polar regions, where it would clear off the snow. Every bit of snow has gone from Canada and North Russia by about the beginning of June, so that it would be quite easy for warm air to sweep across the remaining part of the Polar cap, and the whole ice would go, probably, by the end of June every year. That is what I feel. It is impossible to give a definite answer, but I think a polar cap at sea-level surrounded by sea would retain its snow, and one surrounded by land would lose it.

The PRESIDENT: We are very much indebted to Dr. Simpson for his paper. He has made it quite clear to us that there are plenty of reasons for scientific expeditions to both the Polar regions. I dare say it has happened to most of us to be asked why men of science go to the Polar regions, and it is some sort of discussion such as that to which we have listened which helps us to answer the question. It has been said by one or two speakers that the whole atmosphere must be treated as one; the whole of our weather is linked up with weather elsewhere, and for these reasons we realize, and the experts we have just listened to know better than many of us, that it is very desirable, that meteorological stations should be established in Polar regions. It was interesting to hear from Dr. Simpson that the Poles have not the predominance that we used to think in the weather, and that hot regions still have their very important rôle to play. I take it it will be the general sense of the meeting that the suggestion that a few stations should be established in the Polar regions, and should be established so as to last there some time, is one which should be supported. I feel sure that if it were ever put before the learned societies they would be most willing to support a suggestion of that kind. It only remains for me to thank Dr. Simpson and all who took part in the discussion for the excellence of it and the amount of information which we have gained, thanks to them. I thank you in the name of the Society.

THE MUSLIM PILGRIMAGE

ELDON RUTTER

EVERY one of the 250 millions of Muslims in the world, who is physically able to accomplish the journey, is commanded to perform the Pilgrimage to Mecca once in his lifetime, provided that he is possessed of sufficient means to support himself and his dependants during his absence from home. The relative numbers of the various nations who perform the Pilgrimage are determined principally by the facilities and difficulties of transport. Thus at present the Malays, who inhabit a country 5000 miles from Arabia, normally send the largest number of pilgrims to Mecca, because their islands lie on the great steamship routes between Europe and the Far East. Some 30,000 Malays and Javanese perform the Pilgrimage each year. Most of them are carried in the ships of the three largest Dutch lines, many in the ships of the British Holt Line, and others in those of two lines owned by Indian Muslims. In recent years the British Malayan and Dutch East Indian Governments have issued regulations which have ensured a greatly improved standard in the accommodation, medical supervision, and feeding of the pilgrims on these ships. The result has been a steady increase in the number of the pilgrims. The steamship companies have found this traffic lucrative, for not only are they able to fill their upper holds and decks with pilgrims, but in the lower holds they carry rice, sugar, coffee, timber, and other merchandise for the traders of Jidda. Pictorial advertisements are displayed by the various lines in every town of the East Indies, and cinematograph films showing the incidents of embarkation and of the sea voyage are shown in the cinemas of Java.

The Malays, however, do not send the largest number of pilgrims relative to population. In a normal year the palm in this respect, for foreigners, goes to the Egyptians, who send some 15,000 pilgrims from a Muslim population of not more than 13 millions. The Malay and Javanese Muslims sending 30,000 pilgrims, number some 40,000,000 (including the Muslim population of Borneo and Celebes).

The Arabian pilgrims, of the Hejaz (excluding Mecca itself), Nejd, Yemen, and Hadhramaut, may normally number some 30,000. In the Pilgrimage of 1925, however, I computed that there were quite 35,000 pilgrims from Nejd alone at 'Arafa. It is, perhaps, needless to say that this was unusual. For several years previous to that time King Husain had forbidden the entry of pilgrims from Nejd, whom he regarded as schismatics, into the Holy City. The number, therefore, who wished to perform the Pilgrimage but were forbidden to do so, was constantly increasing. When Ibn Sa'ud drove El Husain from his throne, they were at last free to visit Mecca. Added to this there was the tremendous enthusiasm aroused in Nejd by the victories of the Ikhwan. The people of Nejd came riding into Mecca in thousands to see their great leader in the capital of his enemies, to share in his triumph, and to perform their duty to Allah as pilgrims. There can hardly have been a concourse more proud as conquerors, more humble as servants of Allah, as 'Arafa since the first Wahhabi conquest of the Hejaz, a hundred years ago. I consider that my estimate of 35,000 from Nejd at 'Arafa that year is conservative.

The large proportion of Egyptian pilgrims to population is easily explained. An Egyptian from any part of the Delta can, by timing his departure with precision, accomplish the Pilgrimage to Mecca and be in his own home again within fourteen days of his departure. If he extends his journey to El Medina he may still be home again within less than four weeks. If he were to travel between Yenbo' and El Medina by motor car, which is now possible, he might do the whole journey in three weeks.

Many pilgrims, especially Malays, spend five or six months in the Hejaz. They like to accomplish the Ramadhan fast there. This begins more than three months before the date of the Pilgrimage.

The various divisions of the Indians probably send altogether more than 25,000 pilgrims a year. The fact that, with a total number of more than 70 millions, they do not send more pilgrims is probably accounted for by the extreme poverty of large numbers of them, more than by any other cause.

The number of Afghans who go to Mecca is considerable. They are conspicuous fierce men, reminding one of the Eastern Badawin. One whom I met in the library at Mecca was, at the moment of our introduction, in the midst of a heated argument in Persian with the librarian. He had come across Persia on foot from Herat, without any visible means of support. Reaching Er-Riyadh, he was allowed to ride from there to Mecca on a baggage camel in the caravan of the Amir Faisal, the second son of Ibn Sa'ud. Most of the Afghans travel by steamer from Karachi. Their numbers may be from 5000 to 7000.

The Persian pilgrims are few in number. They are usually watched closely by those Meccans who know their identity. The reason for this, according to my *mutawwif* (pilgrim guide), is that they are always seeking to commit some outrage in order to show their dislike for the Sunnis. Within his memory, he told me, some of them had defiled the Black Stone.

The pilgrims from Morocco, Algeria and Libya may number collectively 10,000, and those from Syria, Turkey and the Balkans about the same. The Kurds, Bukharans, and other Turkomans may amount to 5000, and the Chinese, including the inhabitants of Cochin China, to 1000.

There is a constant trek of pilgrims right across Central Africa. From Senegal, Guinea, Sierra Leone, Liberia, through the French Sudan by the Niger, and through the Gold Coast, they move eastward into Nigeria. They move slowly, trading a little as they go, or working for wages, or begging. Many thousands must pass through the great market town of Kano. Constantly increasing in numbers as they pass through the primitive Muslim regions south of Lake Chad, the pilgrims move steadily eastward. On foot for the most part, but a few of them mounted on camels, they press slowly forward for many months, until at last they strike the Nile or its tributaries somewhere between Gondokoro and Dongola. Many die on the way, and babies are born, for the majority of these Africans have wives travelling with them. The women, during the one, two, or even three years of their long pilgrimage, often bear children on the journey. Having refreshed themselves somewhat at points along the Nile, the pilgrims cross over and continue their journey. They pass on through the Anglo-Egyptian Sudan and Italian Eritrea, or through Abyssinia and Somaliland, to the Red Sea coast. There they embark

in dhows and cross to the Arabian side, landing in the Hejaz, 'Asir, or Yemen, according as the wind blows.

This great trek of Africans is always going on; only in the countries bordering on the Red Sea does it increase at the pilgrimage season. In Western and Central Africa it never ceases. Some are going to Mecca, others are returning. It is impossible to say how many Africans arrive in Mecca during a year. Thousands die before they can reach Arabia; other thousands die in the Arabian desert on the last stage of their journey. Only a small proportion of them pass through the ports of Jidda and Yenbo'. On whatever part of the Arabian coast the dhows are blown by the wind, there the pilgrims are disembarked, the crew show them the direction of Mecca, and on they go.

There is a great village of huts constructed of scrub bushes, camel grass, skins of animals, petrol tins beaten flat, and other material, situated in the Misfala quarter of Mecca. This is where the majority of the Africans live. At the lowest estimate 40,000 of them must reach Mecca every year. Here we have a striking exception to the rule that the largest proportion of pilgrims come from countries whence travelling is easy.

The list of pilgrims is, then, roughly as follows:

Malay, Borneo and Celebes	30,000
Egypt	15,000
India	25,000
Afghanistan and Baluchistan	6,000
Morocco, Algeria and Libya	10,000
Syria, Turkey and Balkans	10,000
Kurdistan, Bukhara and Central Asia	5,000
China and Cochin China	1,000
Central Africa and Sudan	40,000
Arabia	30,000
	172,000

If we add to this the male population of Mecca, together with many of the children and some of the women, we may say that there are normally nearly a quarter of a million people present at 'Arafa on the Day of Pilgrimage.

The most conspicuous elements in the populace at Mecca in the time of pilgrimage are firstly the Malays, by reason of their large numbers and their brightly coloured clothes and turbans, and secondly the Bukharans, who, though not so numerous as some of the others, stand out by reason of their stolid Mongolian features. In 1925, however, all other elements appeared to shrink to a commonplace uniformity beside the religious brotherhood of the Wahhabis. This large dominating desert-Arab element seemed out of place in the cosmopolitan city which Mecca has become.

MOUNTAIN NAMES ON THE INDIAN BORDER

THE seventh chapter of Major Mason's report on the exploration of the Shaksgam Valley and the Aghil Ranges ('Records of the Survey of India,' Volume XXII) discusses the nomenclature of the Karakoram, and makes certain suggestions which are criticized by Sir Sidney Burrard in the article which follows this note. Major Mason not only proposes that the Karakoram shall be called the Karakoram-Himalaya, the Karakoram Range the Muztagh-Karakoram, the Aghil Range the Aghil-Karakoram, and the Kailas Range the Kailas-Karakoram, but he uses these names in his report, which seemed to imply that they had been accepted by the Survey of India, hitherto regarded by us as the ultimate authority on questions of nomenclature along the Indian border. If in rare cases we ventured to adopt the spelling of a high

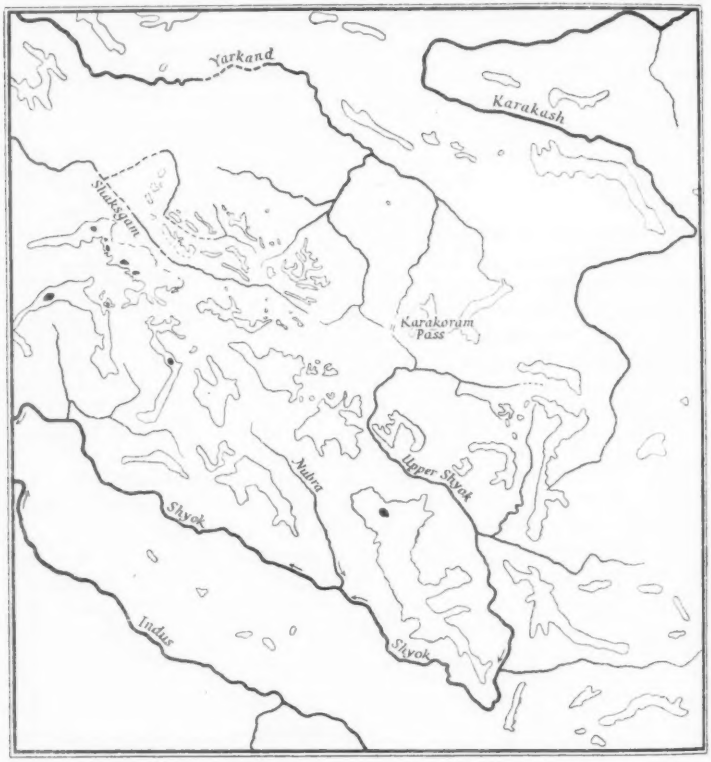


Fig. 1. The Karakoram, from Survey of India 1/Million "India and Adjacent Countries," Sheets 52 Leh, 1916, and 51 Yarkand, 1923, with additions from Major Mason's map of the Shaksgam and Upper Yarkand Valleys 1/253,440, 1928. The contour shown is at 20,000 ft., and the small areas above 25,000 ft. are in solid black

authority rather than of the highest, as in writing Kangchenjunga rather than Kinchinjunga, it was always with some virtuous apprehension.

In his preface to this volume of the Records, dated 17 November 1928, the then Surveyor-General, Brigadier E. A. Tandy, finds it quite clear that "the Karakoram Range" is really a misnomer which has arisen through a series of misunderstandings at a time when the geography of the range was practically unknown, which is Major Mason's main contention; he refers to the "minor questions" of names for the ranges, Aghil-Karakoram, etc., and proceeds:

"I do not consider that this department should decide questions which depend so much on international usage. We can only assist by publishing the suggestions of our best experts, and then hope the Royal Geographical Society, which includes all the principal geographers and explorers interested, will find an early opportunity of discussing these suggestions and arriving at decisions, in which case we shall be happy to accept them and incorporate them on our future maps."

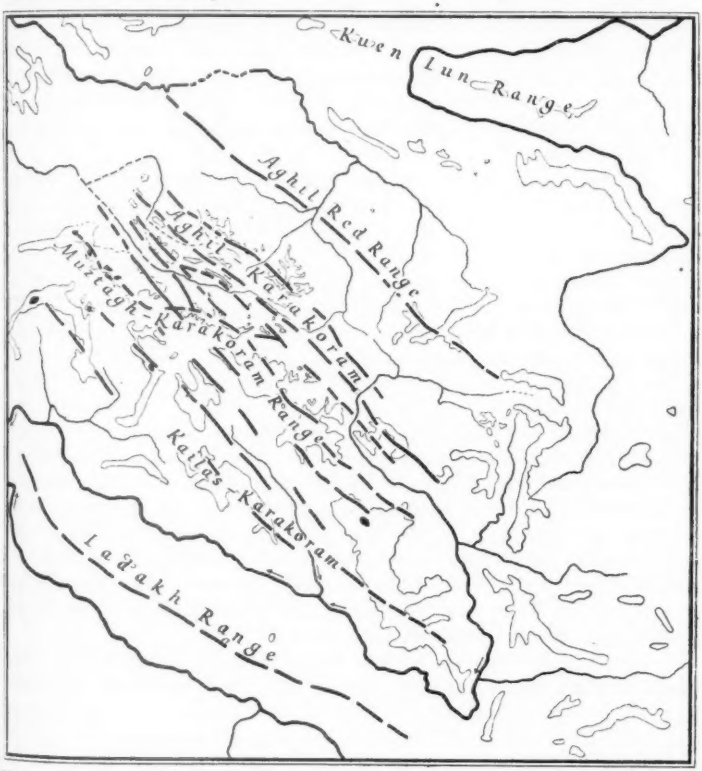


Fig. 2. The Range Lines and Names proposed by Major Mason in his Shaksgam Report, Records of the Survey of India, vol. 22, superposed on the outline of Fig. 1, for comparison of the ranges defined by their geology, with the visible relief of the country

This high and unexpected compliment comes at a season when nothing can be done at once to initiate any formal discussion. But the delay gives a welcome opportunity of inviting preliminary expressions of opinion in the *Journal;* and the contribution of Sir Sidney Burrard, offered and accepted before the important rôle proposed for the Society had been realized by the Editor, makes an authoritative statement of the case against the changes proposed by Major Mason. We shall welcome argument on either side.

The fundamental question appears to be whether a mountain system shall be described in ranges or in regions. There is now general agreement that the Alps are conveniently divided into regions bounded by rivers and passes; and a scheme put forward by a Commission of the Italian Geographical Society was favourably reviewed by Mr. Freshfield in the *Journal* for January 1928. The natural name of a region is then composed of a generic name *Alps* and a descriptive adjective, as *Bernese*. The system has obvious advantages in that the foothills and outlying features find natural places in the border regions, and there is no need for discussion whether geographical or geological considerations shall rule the division into ranges, or whether indeed it is possible to divide the mountain complex into ranges, in the geographical sense: which is, we suppose, a series of mountains arranged more or less in a line, not necessarily straight, standing out from their surroundings, and having a sort of unity as a structure.

At the meeting of the British Association at Southport in 1883 Colonel Godwin-Austen delivered the Presidential Address to the Geographical Section, and devoted a part of it to the Mountain Systems of the Himalaya and neighbouring Ranges of India (*Proc. R.G.S.* 1883, p. 610). In the following year he published a short paper with the above title (*Proc.* 1884, p. 83) to amplify his argument, with a map that is, we may hope, the most illegible map ever published by this Society. The legend under its title reads thus: "An attempt to make the orography more accordant with the Geological structure, and thus lead to the introduction and use of a common nomenclature in Geography and Geology."

The geological structure is indicated by long lines overprinted in red, of which the principal are numbered from north to south, and labelled I. Kuen Lun; II. Mustakh; III. Ladak; IV. Himalaya; V. Outer Himalaya; and VI. Sub-Himalaya. The orography, represented in the old hairy-caterpillar style, has pretty successfully resisted the attempt to make it accordant with the geological structure shown by the red lines; yet the "common nomenclature" requires the geographer to recognize the *Ladak* range as covering 18° of longitude, from somewhere west of Chitral to a point north of Tinki Dzong familiar to the Mount Everest expedition.

To the *Mustakh* Colonel Godwin-Austen gives less extension, but only because at that time nothing was known of the geology eastward. He takes it to 79½° E. in solid symbol, and to nearly 83° in dotted; and it is clear enough from the map that he would have been happy to go on eastwards if he had had any material to support him.

These ideas of Godwin-Austen dominated the Survey of India for the next forty years. The diagram of ranges in Burrard and Hayden's 'Geography and Geology of the Himalaya' is on the same general lines. They take the Kara-

koram range east to 79° definitely, and after a slight break continue it eastwards.

In the map of *Tibet and Adjacent Countries*, on the scale 1/2½ M, published in 1914 by the Survey of India, the name Karakoram Range is actually written between 72° and 92° E.; that is to say, it extends east of Lhasa. But on the same map published in 1920 in a second edition with a new name *Map of the Himalaya Mountains and the surrounding Region*, the name Karakoram range is removed, as are some other range names. But in the margin is a diagram of the ranges based on that in Burrard and Hayden, in which the Kailas and Ladakh ranges extend eastward as before to 92°, but the Karakoram is cut short at 80° E.

It may appear from all this that there is a much larger question to be discussed than whether the Karakoram Pass is on the Karakoram range. To geographers, and still more to climbers, the *Karakoram* has a pretty definite and limited meaning. They would not allow it, we think, to extend east of the Upper Shyok. Should they be obliged to allow the name *Karakoram Range* to be carried right away east of Mount Everest because geologists are ready to identify the sequence of rocks observed in Eastern Tibet with that observed in Ladakh?

These are matters on which opinion may differ widely, and will not easily be reconciled. The Editor of the *Geographical Journal* will be happy to receive the judgments of those interested.

THE MOUNTAINS OF THE KARAKORAM: A DEFENCE OF THE EXISTING NOMENCLATURE

By COLONEL SIR SIDNEY BURRARD, F.R.S.

THE Survey of India has recently published a report by Major Kenneth Mason, R.E., on his exploration of the Shaksgam Valley, a valley situated to the north-east of the Karakoram Range. Incorporated with his report are proposals to make fundamental changes in the nomenclature of the Karakoram region. I ask to be allowed to explain my reasons for preferring our old inherited nomenclature to that now proposed.

The area triangulated by the Survey of India has included the two highest mountain ranges of the world. By good fortune two names of distinction have been handed down to us, a Sanskrit name Himalaya for the Indian range, and a Mongol (Turki) name for the range of Western Tibet. To appreciate this good fortune we have only to consider how many mountains in Asia are without names, and how many are named only snow mountain. Geographers had to name the range on the east of the Pamirs the Kashgar Range from a city in the plains, because it had no name of its own. The two different ranges of mountains that follow the two coasts of India have the same name, the undistinctive one of Ghats. If moreover we look at maps of continents where mountain names have had to be invented, we realize the value of two such names as Himalaya and Karakoram.

The following table will show the names now in use for the mountains of Western Tibet and Mason's new proposals:

	Existing Names.	*Names now proposed.*
The Main Range	Karakoram	Muztagh-Karakoram
The Mountain Region ..	Karakoram	Karakoram-Himalaya
Outer subsidiary range ..	Aghil	Aghil-Karakoram
Inner subsidiary range ..	Kailas	Kailas-Karakoram

Mason's proposed names are too long for the purposes of science or of schools. Amid the confusion of his double names one serious proposal is partially hidden. The name of the second highest range upon the Earth has for fifty years been Karakoram: its primary name is now to be made Muztagh. The preface to Mason's book states that the second name of the proposed compound "is merely a concession." The change of this important geographical name from Karakoram to Muztagh would be most regrettable.

The Geographical History of the name Karakoram

Sixty years ago there was a question concerning the better name for the great range, whether it should be Karakoram or Muztagh. The name Karakoram was chosen by men well qualified to judge. Mason is now raising the same question again, and is basing his proposal to change the accepted name upon inferences he has drawn from history. Mason's explanation of the entrance of the name Karakoram into historical geography is, in his own words, as follows: "It is first of all Moorcroft's misapprehension and then a misunderstanding of Hayward's intention, and of the observations of Montgomerie, of the Survey of India, that has led European geographers to use the term Karakoram Range as it is at present applied."

This statement astonished me. To the best of my belief the European geographers rely upon the maps of the Survey of India for the geographical data of Western Tibet. The surveys of Kashmir and Karakoram under Major Montgomerie, R.E. (1855–1865), opened a new geographical era in those countries. These surveys were carried out under the Great Trigonometrical Survey of India, and the maps were drawn in the Headquarters Office at Dehra Dun. When the drawing had been completed, the maps were sent to London to be engraved at the India Office.

General Walker was the Superintendent of the Survey at Dehra Dun, and Sir Clements Markham was the geographer at the India Office. Major Montgomerie's survey party used to winter at Dehra Dun, so that Montgomerie was in touch with Walker. The Dehra Dun Office worked harmoniously with the map office in London: General Walker and Sir C. Markham were cousins and in constant correspondence.

The dates of the principal events in the history of the Karakoram maps were approximately as follows:

Before 1820	Moorcroft's explorations.
1853–1854 ..	Explorations in Ladakh of Major Alec Cunningham, R.E.
1855–1865 ..	The triangulation of Kashmir and West Tibet by Montgomerie, and the topographical surveys of Godwin-Austen.

1866–1869 .. Fair drawing of Montgomerie's and Godwin-Austen's maps at Dehra Dun under Walker.
1868–1872 .. Publication of the maps at the India Office by Markham.
1876–1878 .. Preparation of Montgomerie's triangulation charts in the computing office at Dehra Dun.
1879 .. Publication at Dehra Dun by Walker of Montgomerie's triangulation.

Moorcroft was the first explorer to apply the name Karakoram to the great range of mountains which separates the Indus and the Tarim basins.

In 1854 Major Alec Cunningham, R.E., gained a remarkable insight into the mountain systems of Western Tibet. His analysis of the ranges is described by Markham in his 'History of the Indian Surveys.' He traced the Karakoram Range with surprising accuracy from the sources of the Gilgit River to the source of the Shyok. Cunningham applied the name in 1854, just as we are applying it to-day. It was Cunningham's exploration that led Montgomerie to use the letter K in his angle book for the distant peaks on his Karakoram horizon, when he was observing them from Kashmir. His use of the letter K is well known in history from his discovery of the second highest peak in the world, which still bears his symbol K_2.

In 1870 Hayward the explorer prepared a map which he headed "The Karakoram Range." I have not seen his report, which Mason thinks has been misunderstood, but I know his map; he depicts the Karakoram Mountains and writes clearly across them "Muztagh or Karakoram."

When in 1872 Montgomerie's new maps were eventually published by the India Office, no name had been given upon them to the great mountain system. The omission was intentional, and it shows that there was some uncertainty and hesitation. That Montgomerie was aware of the name Muztagh is certain, for Godwin-Austen, his assistant, had published papers, "On the Glaciers of the Muztagh Range," in 1861 and 1864. Why did they not adopt this name Muztagh? I can only think of one possible reason, the same reason that led Colonel Wauhope to reject it forty years later, namely, that in the opinion of linguists the word Muztagh is not a name but an ordinary noun of the Baltistan vocabulary denoting "snow-mountain."

In the Himalayas on an autumn morning the hill-man will greet us: "The snow mountains are clear to-day." He will not say, "The Himalayas are clear." And when we meet a European, he will also say, "Are not the snows beautiful?" He will not say that the Himalayas are beautiful. And so the Karakoram villager will say just as others do, but in his own tongue, "Muztagh."

But while Montgomerie and General Walker at Dehra Dun were rejecting Muztagh, they were hesitating to adopt Karakoram. In his survey report of 1860 Montgomerie had referred to the "Karakoram Ridge" and to the "Karakoram Mountains," and in 1861 he had mentioned "the great Range which is called both Muztagh and Karakoram." When was the name Karakoram finally and definitely accepted by the Survey? About 1876 the computing office began to prepare Montgomerie's charts of triangulation, whilst he himself was in Dehra training the explorers for Tibet. The computing office seems to have pressed Walker for a decision, for the name Karakoram was finally adopted upon these charts. These charts, which formed the basis

of future mapping, were published in 1877, and the name Karakoram was written across them. From the triangulation charts the name passed gradually through the drawing-offices to the geographical maps, and since 1880 the maps of the Government of India have been telling the geographers of Europe and America that the great range is named Karakoram. At the India Office Sir Clements Markham showed less hesitation than his colleagues at Dehra Dun, for he adopted the name in his 'History of the Indian Surveys' (1871 and 1878), and on his map in this book he showed the Karakoram Mountains as we do now. And so it will be seen, if my interpretation of history is at all correct, that so far from the name Karakoram having slipped into geography through series of mistakes, it was accepted only after years of deliberation by men who were amongst the foremost geographers of the age, and who possessed an intimate knowledge of the mountain system under discussion.

The questions however still arise: Why had Montgomerie and Walker been hesitating so long? If the name Karakoram was accepted for the charts in 1876, why was it not accepted in 1870 in time for entry upon Montgomerie's maps?*

Before I consider these questions, I should like to refer briefly to the further objections to the name Karakoram which have been raised by Mason.

Mason refers to the use made by Montgomerie of the symbol K for the Karakoram peaks. He thinks that "though Montgomerie did not believe for a moment that the peaks he labelled K were all on a single range," as K_1 and K_6 are not on the main alignment, the system has led to a misunderstanding. Mason adds, "I certainly believe that the naming of K_2 has influenced geographers in retaining the name Karakoram for the single range." In my opinion geographers take their geography of Baltistan from the maps of the Survey, and the Survey has been under no misapprehension about the symbol K. It has been the usual practice for our observers to employ a single letter as a symbol. Montgomerie followed the same course as had proved successful in the Himalaya. His observations were interpreted by the same expert computing office as had calculated the height of Mount Everest.

As I have referred frequently to Colonel Montgomerie, I feel it a duty to record that he did not live to succeed General Walker as Superintendent. His original strength had been sapped by eleven successive seasons of mountain-climbing, and he died in 1878, at the age of forty-seven.

The question of the Karakoram Pass

Another objection raised by Mason to the name Karakoram is that there is a pass known as the Karakoram Pass, and that this pass is not on the main range. The existence of this pass was well known to Montgomerie, to Walker, and to Markham. It has been well known in the drawing office since the 'sixties. Mason does not like the repetition of the same name on both a range and a pass, and he believes (in his own words) "that on maps the Karakoram

*The name Karakoram Mts. does however appear on the map "Turkestan with the adjoining portions of British, Russian, and Native Territories" on the scale 32 miles to the inch, published by General Walker at Dehra Dun in May 1873. The name lies between longitudes 77° 30′ and 79° 40′ E., that is, mostly to the east of the Karakoram Pass. This is the 2nd Edition: the first is not in our collection. The name was removed in subsequent editions, 1875 onwards.—ED. *G.J.*

Range has been made to bend out of its normal alignment, almost to due east, in order to include the pass" (p. 79), because the pass bears the name Karakoram.

May I explain why the range has been made to bend out of its normal alignment? It is simply this: the drawing office took the main watershed of the Indus to be the range. The highest peaks are on this watershed, but farther to the south-east the watershed bends back and curves round through the Karakoram Pass. The watershed would have done this, whatever name had been given to the pass.

When a mountain map is only showing the drainage lines, the watersheds appear to be the main ranges. I have heard the drawing office stoutly maintain that the only ranges which matter are the main watersheds. The difficulties of hill-shading when the drainage has cut back behind ranges have been very great. It is probable that the inhabitants and the Central Asian traders have the same idea of the main range as our drawing office had, namely that it is the watershed. If they have ever considered the question at all, they would probably argue that the Karakoram pass is on the Karakoram range, because they have to climb over that pass to get from one side of the range to the other. Cannot we regard this Karakoram Pass as the entrance door from Yarkand into the Karakoram region? The objection to its name would then disappear.

Moreover, before we can reject the name Karakoram because of its duplication on a pass, we must remember that the proposed alternative Muztagh is repeated in many places. The late Colonel Wauhope, who explored the Pamirs and the Hindu Kush, wrote in 1906, "Muztaghs are as common all over Central Asia as Safed Kohs (white mountains) are on our north-west frontier. The name Karakoram is quite established now for the mountain ranges separating the Indus and the Zarafshan and is the most suitable."*

The high peak described by Sven Hedin is named Muztagh Ata (father of snow mountains) and is not on the Karakoram but on a range farther north which Hedin calls the Muztagh range. Sir Aurel Stein found the name Muztagh in the Kuen Lun range, and Semenoff found it in the Tian Shan.

The derivation of the word Karakoram

In the opening paragraph of Mason's book he writes:

"The name Karakoram means 'black gravel,' and this inappropriate name has been restricted by geographers to the whitest, iciest range of mountains outside the polar regions. It seems a pity; for to call black white and white black impresses nobody with our sense of sagacity."

May I say a few words on behalf of our predecessors? There is a belt of perpetual snow broken only by gorges stretching from Sikkim to the Pamirs, and within this belt it is desirable to avoid the name "snow mountain." Mason compares Tibet with the polar regions, but the name "snow mountain" would not be distinctive in the polar regions. Like Mason I have believed, and our predecessors believed, that the Turki word "Karakoram" meant "black gravel." But now that this meaning has been put forward as a reason

*"Geography and Geology of Himalaya Mountains and Tibet," by Burrard and Hayden (1907), page 97.

for changing nomenclature, I have thought it advisable to verify it. In Shaw's Turki dictionary the following meaning is given:

Kara	..	Black.
Koram	..	Ground covered by large blocks of stone fallen from mountains.

I cannot fairly use this latter meaning against Mason, as it is quite new to me. But what Mason has disliked is the word "black," and this word must remain in any translation. The word "black," however, is common in geography, and generally means angry, or stormy, or dangerous. There is the Black Sea and the Black Forest, and in India the people call the ocean the Black Water. In all such cases our forerunners who initiated the names were looking deeper than the surface colour. To call a white mountain black is only absurd if we cannot look deeper than its snow; but if we look into its character and think of its thunderstorms and avalanches, we understand the mind of the people who called it black.

And before this old name Karakoram is set aside on account of its derivation, we should consider whether it may not have originated in quite another way. Peoples sometimes borrow names from outside; in London we have borrowed Waterloo and Trafalgar. The English carried their names Boston and Hampshire to America; the Scotch took Perth to Australia. In the thirteenth century the Asiatic empire of Gengkis Khan reached from Peking to Warsaw; its capital city was Karakoram in Mongolia. The name Karakoram was known everywhere. The immense armies of Gengkis Khan, always living on the country they traversed, were in possession of the Yarkand area for a century. They reached India through the Kuram valley, and finding the heat of Lahore unbearable, they tried to get back to their home at Karakoram by way of Kashmir. Their armies were however too large, their horses too numerous, and they found their way "blocked by the massifs of impenetrable ranges."* Is it not possible that Gengkis Khan's army to whom Karakoram was the centre of the world brought this name into Western Tibet? Is it not possible that some of his soldiers, wearied with years of war, took the opportunity of escaping from military service and stayed behind in Tibet, when the army had to retire from the mountains in confusion?

Gengkis Khan of Karakoram was an ancestor of the Mogul emperors of Delhi. The Karakoram mountains standing between India and Mongolia thus form a monument to the two Mogul empires of Asia. And at the summit of the Mogul monument we see Montgomerie's flag, the mystic symbol K_2, more popular now throughout the continents than any name; it is the symbol of geographical triumph, and it memorizes the alliance of many races of men, British and Indian, Pathan and Kashmiri, Ladakhi, Balti and Tibetan, in a long-united endeavour (1855 to 1865) to lay bare the secrets of the formidable mountain barrier.

The name of the Mountain Region

It is now proposed to change the name of the mountain region. Hitherto the names of the region and of the great range have been the same, namely,

*Lamb's 'Life of Gengkis Khan,' page 186.

Karakoram. It is now proposed to name the region Karakoram-Himalaya and the range Muztagh-Karakoram. It has, I think, been a common practice in geography to apply one and the same name to a mountain region and to its main range. We speak of "the Himalayan region" and of "the main Himalayan range." We also use the plurals Himalayas and Himalaya mountains to denote the whole region. The region and the plural include the whole complex mass of main and subsidiary ranges, outliers, spurs, and foothills. We do not, I think, require different names for the mountains and for the highest range.

From a scientific point of view also it is, I think, inadvisable to emphasize too strongly the difference between the range and the mountains. Although the range may be crowned by a crest-line of high peaks, its walls and buttresses and foundations are part of the mountain mass. As for the newly proposed name Karakoram-Himalaya, it is distressing to see the Sanskrit name Himalaya applied to the Mongol region. The name Himalaya is reserved for the mountain ranges forming the southern wall and buttresses of the Tibet plateau; it is not taken by surveyors into Tibet across the Tsangpo or Indus. On Mason's map the Yarkand river is shown in a Himalayan region; and the incongruity is striking.

The Kailas Range

This range is a secondary range of the Karakoram system on the south-western flank. Mason proposes to change its name from Kailas to Kailas-Karakoram.

Major Alec Cunningham was the first explorer to describe this range, and when he explored it, in 1854, it was nameless. Cunningham thought that as the sacred peak of Kailas was standing on the prolongation of this range it would fix the range in geography to name it the Kailas Range. Mason puts forward a different view. He regards this range as being more in "unity" with the "parallel Karakoram Range" than it is with Kailas peak (p. 75). He proposes to add the name Karakoram to the old name Kailas and to call it the Kailas-Karakoram range, as this "would bind the individual ranges together in a lateral sense," and make clear "their essential unity." The difference between Cunningham and Mason depends on the word "unity." Cunningham did not use the word, but he evidently regarded the unity of a range to lie in its succession of high points marking its alignment, for he called it Kailas, because the Kailas peak was on its distant prolongation. Mason writes of "its unity with the ranges to the north." Cunningham was thinking of geographical unity and Mason is implying geological unity. In my opinion the former is the sounder basis for a geographical name than the latter. Similarly the simple name Aghil seems preferable to the proposed compound Aghil-Karakoram: the former is clear, the latter obscure.

The problems of nomenclature in a desolate country are different from those of populated areas. In the outer Himalaya the local names are numerous, but as we enter the mountains the names become scarcer, until on the Tibet border the passes are the only features named. In the lower hills the inhabitants have furnished all the names that geography requires, but at higher altitudes the requirements of geography are not satisfied by the few local

designations in use. In recent times explorers have told me that they have taken vague names off the land in Tibet and have applied them to unnamed prominent peaks, a course I believe to be wise.

The inhabitants of Baltistan had always been content with a scanty nomenclature, but when the peak of K_2 was discovered in their midst, their country became a focus of geographical interest. Throughout their mountainous region only one proper mountain name (apart from a few snow peaks) had been forthcoming, and that was Karakoram. This name was probably not a precise designation amongst the Baltis; otherwise there would have been no uncertainty. But indefinite as it was, it had been found floating over the hills for fifty years; Moorcroft heard it in 1820, Cunningham in 1854, Hayward in 1870. Eventually Montgomerie took this local name and attached it to the highest mountains of the country.

Montgomerie's orders had been "to survey the territories of the Maharajah of Kashmir," and he had consequently had to stop his work at the crest-line of the great range. He knew nothing of what was beyond. He may have thought that peaks higher than K_2 might be standing behind. Furthermore, he may not have wished to define the valuable name Karakoram, until he knew to what extent it was employed on the farther side of the crest-line. It seems to me possible that Montgomerie may have hesitated until he had obtained information concerning the hinterland. The final responsibility for introducing the name Karakoram into geography rests, however, upon Montgomerie's two chiefs, General Walker and Sir Clements Markham. It is only fair to their memory to admit that their decision to adopt the name has been a benefit to science and has caused no inconvenience to the Baltis.

In the *Encyclopædia Britannica*, 1883 (Tibet), Sir Richard Strachey wrote that the name Kuen Lun was introduced by Humboldt, and that "this designation is not locally known." In 1929 the name Kuen Lun is firmly established in geography, and the claims of Karakoram are even stronger. The name Kuen Lun is an international possession, but that of Karakoram is in British keeping. It is easy to change and to modify an old name, but we cannot create an old tradition. The value of traditions to a Survey and to geography is inestimable; their growth has been due to the continued cooperation of successive generations of men, and if we can preserve the traditions that come down to us, we shall leave them to our successors with their values enhanced.

SIXTEENTH-CENTURY CARTOGRAPHY

A. ORTELII CATALOGUS CARTOGRAPHORUM, bearbeitet von LEO BAGROW. Erster Theil (von A—L). (Dr. A. Petermanns Mitteilungen, Ergänzungsheft nr. 199.) *Gotha: Justus Perthes* 1928. 11×8 *inches;* 138 *pages; and facsimiles*

A VALUABLE source of information on early and mid-sixteenth-century cartography is the Catalogue printed by Ortelius in his 'Theatrum,' in which he gives the names of a large number of his predecessors whose maps he had made use of, or were at least known to him. Some of these maps are now known only through their mention in this way, while others are excessively rare. It was therefore a useful idea of Mr. Bagrow (who is known for previous studies of early maps) to start from this catalogue and trace all that can be learnt on the work of each of the authors therein mentioned. The results are being published in the *Ergänzungshefte* of *Petermanns Mitteilungen*, No. 199 of which deals in alphabetical order with all the map-makers in the list whose names fall between A and L inclusive. The task has involved much research and a wide knowledge of previous writings, and the work promises to be one of the most important for the history of early printed maps that has appeared for some years.

The present instalment begins with a sketch of the output of Ortelius himself, and then reprints the Catalogue from the first edition of the 'Theatrum' (in which it includes eighty-seven names), with additional data from later editions printed in italics. The authors now treated of number forty-nine, and Mr. Bagrow has been at pains to trace out all that is possible of the life-history of each, besides recording their whole known output in chronological order, with a serial number for each item inset in the margin. For each important map he deals with its re-issue by, or influence exerted on, later map-makers. Useful references are also given to the places where the scarcer maps are preserved, to their discussion by previous writers, and to modern reproductions. We cannot but admire the industry and perseverance that has made this mass of information available in convenient form.

As regards Ortelius himself, it is pointed out that even now the imposing list of editions of the 'Theatrum' cannot be regarded as complete, for unrecorded editions continue to be found, *e.g.* a German version preceding that of 1592 has lately been acquired by the Staatsbibliothek at Berlin. Besides his *magnum opus* and his rare map of the world in eight sheets (1564), of which the British Museum lately acquired a copy (Mr. Bagrow knows only that preserved at Basel), Ortelius issued separately (1571) a large map of Spain in six sheets by Carolus Clusius (Charles de l'Ecluse), his connection with which is proved only by his own statement in the 'Catalogus.' Another map by Clusius—Gallia Narbonensis—was used in the 'Theatrum,' though its authorship is mentioned only in the text at the back. This is an illustration of the close study needed to arrive at the facts: occasionally Ortelius himself is shown to be at fault, as when he speaks of a *map* of the Fiechtelberg made by Caspar Brusch, the *tabula* in question being almost certainly a description only.

The work of the greater cartographers like Apianus, Finaeus, Daventer, Gastaldi, or Lazius, is fully dealt with, and the section on Gastaldi is particularly valuable, no fewer than 109 separate maps by this prolific Italian cartographer being given.* But the larger part of the catalogue is made up of the

*One or two of the conclusions reached are perhaps open to question, *e.g.* there seems no valid reason to reject the view that Gastaldi's pamphlet of 1562 (in which the Strait of Anian is spoken of for the first time) was accompanied by a new world map, supposed by Almagià to have closely resembled the known version of 1569.

names of lesser men, of whom little is known, and many of whose maps still await discovery. One is in fact impressed by the large amount of original cartographical work done in the time before Ortelius, much of it of a special character, which the atlas-makers both of the Netherlands and of Italy found ready to their hands. A few of the still unknown maps may be specified, *e.g.* two maps by Bordone—one of Italy, the other a circular map of the world; one of Palestine by Martin Brion, said to have been published in Paris (Bagrow thinks, however, that there was a confusion with one "Bironius," whose map of Palestine is mentioned by Adrichomius); one of Lombardy by Bonaventura Castiglione (perhaps never actually published); maps of Saxony and Bohemia by Johann Criginger, whose labours in this field have so far met with little attention; one of Germany by Carl Heydanus, said to have been brought out by Hieronymus Cock of Antwerp. No copy of the English version of Cabot's big map of 1544, formerly to be seen in "her Majesties privie gallerie" at Westminster, is now known, or of the original issue (1525) of Finaeus's big map of France; and we are still ignorant whether Jenkinson's map of Russia, first made in 1562 and afterwards used by Ortelius, was ever published independently. So a wide field is open for further research.

A good many of the details given by Mr. Bagrow are not widely known. Thus the existence at Dillingen of a copy of Lily's map of the British Isles (1546), though mentioned by Ruge, seems to have been overlooked in this country, and we were not aware that a copy of the map was issued in 1548 by the French publisher Gourmont, to whose credit we must also place the issue of Finaeus's heart-shaped map of 1536 and (if Ortelius is to be trusted) a map of Palestine by Brion. The map of Finaeus, like so many others, was copied by the Italians, and besides the well-known issue reproduced by Nordenskiöld, Ruge found one at Nürnberg drawn by "Jacobus fráchus" and published by "Rafael faitel." We have lately received from Mr. W. A. Engelbrecht of Rotterdam a photostat of another (?) example, now in his possession, on which the above names have been written in an old hand, that of the author apparently reading as "Jacob Franchy."

In dealing with so wide a subject it was inevitable that some slips should occur, and Mr. Bagrow asks that any noted should be reported to him. On p. 54 he suggests that Clement Adams' reissue of the Cabot map was of a part only, being misled by Hakluyt's use of the word "extract" in connection with it. This really describes Hakluyt's own quotation from the letterpress of the map. On p. 97 he says that the map of Spain by Geminus is in the British Museum, whereas the only known copy seems to be in the Bibliothèque Nationale. In dealing with the Austrian maps of Lazius, he makes no mention of the Italian reduced copies to be found in the collection at Trieste, and (some only) in the British Museum volume spoken of in the *Journal* for April last (p. 364). He has not unnaturally failed to note that some of the rarer maps (*e.g.* Gastaldi's Lombardy, by Tilman) exist in this Society's collections. His views as to the relations between Lafreri and contemporary Italian map-publishers seem to need some revision, for he speaks more than once as if Gastaldi and others had made their maps to Lafreri's order, rather than independently, in the first instance at least. But on the whole we have noticed remarkably few mistakes. Twelve plates of map reproductions are given at the end, one being the rare map of America (1562), by D. Gutierrez, preserved at the British Museum. The conclusion of the work will be eagerly awaited. E. H.

REVIEWS

LA PLANA DE VIC. By GONÇAL DE REPARAZ. Chapters I and II by J. R. BATALLER. Enciclopedia "Catalunya," Vols. 8 and 9. *Barcelona: Editorial Barcino* 1928. 8×5 *inches;* 340 *pages; illustrations, diagrams and maps.* 13 *ptes*

Vic (Vich), the ecclesiastical capital of a long strip of country lying behind the inner mountain chain of Catalonia, gives its name to the eastern portion of the diocese, the Plana de Vich, for which the road from Barcelona to the Cerdagne by the Congost, Meder and Upper Ter is the axial line. Rising some 2000 feet above the river flats to the summit of the *plas*, or tablelands, which slope gently north-westwards from the Montseny to the Pyrenean foothills, the Plana is nevertheless barred from the Mediterranean Sea, less than 20 miles distant, by the mountain wall to the south-east; thus it scarcely feels the tempering influence of the sea unless in summer, which is a season far from rainless, the winters being cold and dry, and January and February being the driest months of the year.

The scholarly little work under review is most interesting as a study of the historical development of a Catalonian region, the geological description is in the competent hands of Sr. J. R. Bataller, and the whole work is worthy of the distinguished name borne by its author; it justifies, in short, the labour needed to decipher the Catalan language in which it is written. R. A.

LES PANORAMAS DU MONT BLANC, By ROBERT PERRET. *Chambery: M. Dardel* 1929. 12×9 *inches;* xxii+[424] *pages; illustrations and map*

This rather cumbersome volume consists of a large and varied series of panoramic views from selected summits in the Mont Blanc *massif*, together with brief explanatory notes on each picture, an exceedingly interesting introduction to the work as a whole, and an excellent coloured contour map of the district. One of the author's chief reasons for publishing these views is stated to be that "chacun de nos grands massifs Alpins possède des caractères pittoresques qui lui sont propres, et qui sont dus à la variété des conditions physiques."

While there is a certain flatness about many of the photographs, which are reproduced in sepia, a number of them are exceedingly good both in themselves and for their topographical value. In particular we may notice the view of the Aiguille du Plan and the Aiguille de Blaitière from the Greppon; that of the Grands Charmez and the Greppon from the southern peak of the Blaitière; and that of the Grandes Jorasses and the Aiguille du Géant from the Aiguille du Midi; with these we may include several panoramic views from the summit of Mont Blanc itself. The etymological notes on the origin of the names of some of the peaks and places mentioned are interesting. Speaking of the Greppon (which the author maintains is the more correct form of the Chamonix Aiguille usually known as "Grepon") he observes, "Cette forme, parente des *Greppen* de la Suisse et identique au *Greppon Blanc* du val d'Hérémence, vien du romanche *Crap*, qui signifie rocher." Altogether the book is well deserving of attention, and to those more or less familiar with the region in question the preface and notes will afford special interest and information. W. W.

EXPRESS TO HINDUSTAN. By M. H. ELLIS. *London: John Lane, The Bodley Head Ltd.* 1929. 9×6 *inches;* xvi+308 *pages; illustrations and folding map.* 12*s* 6*d*

This is an account of an attempt by two Australians and an Australian-born motor engineer to travel overland to Australia via Constantinople, Baghdad. Delhi, and Singapore for the purpose of testing an experimental model of a car designed for rough usage. The expedition left England later than was antici-

pated, in February 1927; the car showed signs of faulty design after two or three days only, but eventually struggled on, with the assistance of various spare parts ordered by cable, till Delhi was reached and the monsoon compelled them to abandon the attempt. It has been recently said that the present-day explorer or traveller meets with no adventures of importance; if he does it is merely evidence of faulty plans or organization. The present book serves to show what a multitude of adventure can still be found not far from the beaten track if one likes to court it. One can get lost in the snow in Southern Germany, become involved in a battle between rival taxi-drivers in Constantinople, even be lulled to sleep by the patter of rats amongst the respectable hotels of Petits Champs, and live an amazing life for several weeks bivouacking in the waiting-room of a Turkish railway station (while the *wagon-lits* train halts obligingly day after day). The book is essentially the story of the car and its drivers: there are thirty-two illustrations from snapshots, the car appears in twenty-six of them. The story is attractively and amusingly written, but marred by an unfortunate tone of superiority and egotism quite unwarranted by the results. A far longer trip, from Peking to London, following precisely the same route, was successfully performed only a few months later by an English party—including a woman—in an ordinary standard-model car purchased second-hand from a Chinaman. On pp. 218–219 there is a description of leaving a well-known and very well organized Eastern hotel which is almost libellous; it is only fair to state that a few months afterwards the reviewer found the staff politely contented with the usual 10 per cent. addition to the very moderate bill. L. D. S.

AU PAYS DE TAGORE: la civilisation rurale du Bengale Occidental et ses facteurs géographiques. By ARTHUR GEDDES. *Paris: Armand Colin* [N.D.]. 10×7 *inches;* iii+235 *pages; map and illustrations.* 25 *francs*

The contour line of 250 feet in Western Bengal marks approximately the step up from the newer alluvium of the present Ganges–Brahmaputra delta to the older alluvium and the laterite of the higher ground which farther west meets the outlying spurs of the Chota Nagpur plateau. This borderland of the delta is traversed by streams flowing east to the Bhagirathi or upper Hooghly, and the country between two of these, the Adjai and Kopai, about 100 miles by rail from Calcutta, is the special subject of Mr. Geddes's interesting and exhaustive study: a study of the geography, especially on its human side, of a part of the *Rarh*, an ancient division of Bengal, and once a leading seat of Bengali culture. The object of Mr. Geddes's study is to trace the causes of the decadence of this region, and to give some account of the attempts being made at Sri-nikitan (*abode of prosperity*), a school of practical effort, to bring about an improved state of things. Sri-nikitan is closely associated with Santi-nikitan (*abode of peace*). a centre for the study and development of Indian culture and art, founded by the poet Rabindranath Tagore on the site of a retreat established by his father Debendrinath Tagore on this bare plateau with its far-reaching views.

Mr. Geddes begins his study by giving, with many particulars of interest, an account of the physiography of the region, including pleasantly written chapters upon its plant and animal life. He points out with truth that some of the ancient divisions of Bengal, *e.g.* the *Rarh*, *Bagri*, and *Barind*, were real natural regions, which the modern administrative divisions are not. Mr. Geddes then proceeds to discuss the *Rarh* as a cultural region, and its contribution to the intellectual development of Bengal. The statistics of the distribution of Brahmans appear to show that until the beginning of the nineteenth century the part of Bengal most prolific in genius was the *Rarh* from the edge of the older alluvium to the east bank of the Bhagirathi. He describes the land and water communications

of the *Rarh*, and their relation to its history in peace and war; also the types of dwelling-house, Hindu and Muhammadan, and the villages, with plans of Hindu and Muhammadan villages in the special area of his study. And he traces the decline of the region to the gradual eastward shift of the live delta, and, in a less degree, to the destruction of forest on the higher lands to the west, and the resultant soil erosion and silting up of drainage channels. All this prepared the way for the malaria which has so disastrously affected the region for the last hundred years. The cultivators, naturally fatalistic, became apathetic. They could not see the causes of effects which only made themselves apparent in the course of generations. The work of rural renovation begun by zealous workers at Santiniketan and Sri-niketan has shown that the cultivators are ready to adopt ameliorative measures whose practical utility has been demonstrated to them by their successful operation under their own eyes, and Boy Scouts have done useful work by getting into touch with the cultivators and proving to them the advantage of mutual help and common effort.

Mr. Geddes has made abundant use of information collected from Government publications and other sources, and the bibliography at the end of the volume covers five pages. Work of the kind done by Mr. Geddes is of the greatest value, and India offers endless opportunities for similar studies. It is to be hoped that his example will be widely followed, and that the results will be published in English. W. H. A. W.

EXPLORATION OF THE SHAKSGAM VALLEY AND AGHIL RANGES, 1926: Records of the Survey of India, Vol. XXII. By Major KENNETH MASON, M.C., R.E., Superintendent, Survey of India. *Geodetic Branch Office, Survey of India, Dehra Dun* 1928. 10 × 6 *inches;* xii + 182 *pages; illustrations and map.* 3 *rupees, or* 5*s* 3*d*

The substance of this report is familiar to us from the lectures given by Major Mason on his return from the Shaksgam (Evening Meeting, 24 January 1927, *Journal*, 69, 280) and after his visit to Flums to plot the stereo-survey on the Autograph (Afternoon Meeting, 9 May 1927, *Journal*, 70, 342). The present publication supplements these two important papers with more complete details of the outfit and the route, discussion of the transport problems, care and health of the porters and baggage animals, supplies and rates of payment. A candid statement of occasional mistakes or errors of judgment adds much to the value of the book for those who may contemplate travelling in these difficult and inhospitable regions.

Forty years ago Sir Francis Younghusband came first into the Shaksgam Valley by the Aghil Pass from the north, with a minimum of baggage and no instrument but a sextant. From Durbin Jangal he discovered and ascended the Urdok glacier, determining latitudes which have proved excellent, but unable to fix his longitude. The precise place of the glacier and the identity of the col at its head remained uncertain until Major Mason's stereographic survey solved the problem. But the phototheodolite with its accessories of heavy plates and travelling dark-room required transport on a scale altogether different, which in the end defeated his object of actually reaching Durbin Jangal from the east or surveying the Urdok. We have now from his surveys so precise a knowledge of the peaks and ridges that uncertainties of position in the valleys and gorges are confined within very narrow limits, and a resolute traveller moving as light as Sir Francis moved, could probably fill in the largish blanks still remaining on the map with fair accuracy and complete certainty. The power of defining crests from a distance is perhaps the strongest point in favour of the stereotopographic method; and we may hope that this first considerable success in long

range stereogrammetry will encourage the chiefs of the Survey of India to push such surveys forward as far as possible on all their borders. Crest-lines are far more comprehensive than isolated peaks.

The important chapter on geographical conclusions, and proposals for a revised nomenclature of the Karakoram ranges are dealt with elsewhere in this number (pp. 274 and 277). Chapters ix to xii deal with the geology, animal life, flora, and meteorology of the Shaksgam. Three appendices on rations and supplies, clothing and equipment, and transport, will be invaluable to subsequent expeditions; and a fourth appendix on geographical names may serve as a model for the conduct of explorers. Starting with Burrard's principle: "The nomenclature of a mountain region should not be forced: it should grow spontaneously, and we should never invent a name until its absence has become inconvenient," Major Mason and his companions encouraged their men to name places, but they never named a single mountain, and the names they gave to passes and valleys had to be dragged out of them. At Leh all the names were overhauled by the Moravian Mission and their meanings investigated; the result is a careful and scholarly appendix of great value as a guide and example. Shaksgam means "a box of pebbles" or possibly "dry pebbles." Kyagar Thso is the "grey-white lake," and the *h* is aspirated. The Ladakhi does not discriminate much between a ravine and an open valley, but is greatly concerned with euphony, using feminine forms such as *lungmo* for *lungpa* (valley) whenever he thinks it sounds better. We are assured again that the glacier should be Rimo and not Remo; but there is no comment on the spelling Shyok, which should surely be Shaiok.

It is superfluous for us to congratulate Major Mason on the success of his Shaksgam expedition: he has received the Founder's Medal for it; but we may remark that this account is very well arranged and written, as befits the honorary editor of the *Himalayan Journal*. A. R. H.

THE PEOPLING OF AUSTRALIA. Edited by P. D. PHILLIPS and G. L. WOOD. (Pacific Relations Series No. 1.) *Melbourne: Macmillan & Co. Ltd., and Melbourne University Press* 1928. 8×5 *inches;* xii+300 *pages, and maps.* 6*s*

This symposium, by eleven members of the staffs of Australian Universities and members of the Government Service, includes the most carefully prepared studies of the Australian population problem yet made. The general introduction by Phillips and Wood, both Lecturers at Melbourne University, is followed by a study of Australian population by the Government Statistician, C. H. Wickens, of the legal aspects of emigration by Professor Charteris of Sydney, of the eugenic aspects by Professor Agar, and of the optimum population by Dr. Benham of Sydney University. The essays on the racial position, urbanization, climatic factors and tropical settlement are by Jens Lyng, MacPhee, Barkley and Cilento, all Government officials. The papers have been prepared for the Pacific Relations Conference and are all the work of the best available Australian authorities; they are marked by full knowledge of the evidence and sympathetic consideration of opposing views. The authors are not fully in agreement. Thus the editors consider the articles by Professor Agar and Jens Lyng as too much influenced by the "nordic myth." Benham regards the maximum desirable population of Australia as between ten and fifteen millions, which others regard as too low. According to some the tropical north is impracticable for white settlement, while Dr. Cilento emphatically claims that white labour in Queensland has proved a complete success, and he rejects the views to the contrary as based either on erroneous assertions or on vague generalizations. He concludes (p. 240), "The figures presented above leave no loophole for the

most ingenious exponent of the old theory. They prove definitely that the white man can live and thrive in the Australian tropics; that the white woman can accompany him without any loss of fertility, mentality, or physique."

In spite of such disagreements the authors appear to be in general agreement that the estimates of an Australian population of 100 million and of an immigration capacity of 100,000 per annum are far in excess of what is practicable. They admit that these figures, of which the latter is somewhat above the number that I advanced in 'Human Migration and the Future,' 1928, are generally accepted. Their lower figures are based mainly on the views that one-third of Australia is desert, and that in much of the rest the rainfall is so uncertain that the country is practically useless, and on a comparison with the population of the United States, and especially of its western districts. In regard to these comparisons it should be remarked that the United States is admittedly underpopulated, and that it is generally considered that its population will by a century's time have at least doubled.

Mr. Barkley, in a valuable chapter on the climatic factors, estimates for Australia a potential population based on comparison with the Western United States of 29,603,000, and with all the United States of 45,996,000; but if the population of the United States be doubled, and that of the Western United States quadrupled, Australia should attain the 100-million estimate. The constitution of the 29,600,000 for Australia is shown in detail on p. 200, where Victoria is credited with a potential population of 1,613,000. The total population of Victoria, as given on p. 218, is already 1,696,670; and if one fact is clear as regards the future of Australia, it is that Victoria could accommodate a population at least several times as dense as it has at present. The great undertaking for the electrical utilization of Victorian brown coal is based upon the expectation of an increased and more widespread population, and greater industrial development. If the possible population for the continent is as greatly underrated as that for Victoria the 30-million limit for Australia will be far exceeded.

Messrs. Phillips and Wood treat with courteous consideration views from which they differ; they remark that my view that the increase of the Australian population from 6 million to 25 million without immigration would probably take two centuries is "a quite unjustifiable statement," and based upon "some strange illusions." That estimate still seems to me quite probable. The Australian population has been growing at the high rate of about 2 per cent. per annum; a quarter of it is due directly to immigrants, who as they are mostly young adults contribute far more to the birth-rate than their numerical proportion. Without continued immigration Australia would appear to have little chance of great industrial development, and the growth of its population could be expected to be similar to that of some other agricultural countries in which doubling the population takes more than a century. J. W. GREGORY.

MOUNTAINS, GOLD AND CANNIBALS. By DORIS R. BOOTH. *London: Cecil Palmer* 1929. 9×6 *inches;* xvi+179 *pages; illustrations.* 7*s* 6*d*

This book is a simple yet inspiring record of a woman's courage and endeavour in the goldfields of New Guinea. In 1924 a new field was reported at Bulolo in the Morobe district, and Mrs. Booth and her husband, who were then living in New Britain, determined to try their fortune. No white woman had ever been in this area before, and Mrs. Booth's application for a permit was refused. But she had set her heart on going, and go she did. More than that, since it became essential for her husband to push on ahead of her, she undertook to bring their 150 loads across the 70 miles of mountainous country that lay between the coast and Bulolo—a journey which required more vigilance and enterprise than those

unfamiliar with New Guinea climate and geography (to say nothing of deserting carriers) might suppose. Her way led through as yet unsettled country inhabited by cannibals, but, so far from molesting her, on one occasion they pressed her to accept a human foot for dinner.

Mrs. Booth remained at Bulolo (the only white woman) for three years. As time went on her husband's efforts met with success. Fresh finds were made at Edie Creek—finds so rich that a rush set it, followed by a dysentery outbreak. It was then that Mrs. Booth's hardest work began. She had been a nurse in the Brisbane General Hospital, and both created and took entire charge of the medical arrangements. In a day her boys had erected an emergency hospital with accommodation for thirty beds; white patients were treated in her own house, and later a third building was used for general cases. Under conditions that must have been indescribably difficult Mrs. Booth worked from 5.30 a.m. till midnight, at times with fifty cases, her only assistant a native orderly. She writes unassumingly and makes little of her trials, but through her pages shines a courage that refused to accept defeat; and it is good to learn that her work earned the warmest thanks of the Administration which had done its best to prevent her going to Bulolo. O. R.

A VOYAGE ROUND THE WORLD. By Capt. G. SHELVOCKE. Edited for the Seafarer's Library by W. G. PERRIN. *London: Cassells* 1928. 9×5 *inches;* xxii+262 *pages; illustrations and map.* 10*s* 6*d*

Shelvocke's voyage was set forth as a commercial speculation, but the profit which it brought to the speculators must have been small indeed. It was not designed for the purpose of exploration or discovery, but it made valuable discoveries, which were entirely neglected; Shelvocke's narrative, though written as a vindication of his own character, holds its place in literature partly because the blunt seaman wrote good English, partly because one petty incident in it was made the theme of an inspired romance, but chiefly as a revelation of the inherent sordidness of privateering.

It is still disputed whether Shelvocke or Betagh, his captain of marines, whose rival account of the voyage unfortunately has not been reprinted in this series, is the more deserving of credit. Preference has of late been given, perhaps wrongly, to Betagh; but it seems better to discount them both, and to decide that the truth lies somewhere between their very conflicting statements. The exact truth can never be recovered, nor need this be a matter of regret, for no more is at stake than the characters of a couple of men who were both indubitably rogues. Neither the course of the voyage nor its main facts are in dispute, but only the proportion in which the blame for many shady actions is to be shared among the actors. Geographically, the chief interest of the book lies in the fact that its author was one of the "buccaneer writers" who served virtually as the only guides for navigators on the Pacific coasts of America until after Anson had followed their route. Anson perforce used them, not without frequent sneers at their untrustworthiness—though indeed the sneers may be Walter's rather than Anson's own—and Shelvocke himself comes in for frequent mention; but the state of navigation in the first half of the eighteenth century is as well illustrated by Anson's difficulty in finding Juan Fernandez, as in anything that Shelvocke says of people looking vainly for an island which they said they had visited before, but which he averred did not exist.

One of the most puzzling things about Shelvocke's voyage is that his rabble of a crew, in spite of much hardship, especially after they left Juan Fernandez in a make-shift craft with worse than makeshift victuals, remained free from scurvy for two whole years. Woodes Rogers, ten years before, on his much

better disciplined expedition, was similarly free; but Anson, twenty years later, was all but unmanned by it when he reached Juan Fernandez. At present there is no explanation of these discrepancies. It may be that scurvy is, or was, a disease capricious in its incidence; that it may, like some epidemics, have taken a mild form at one period and a virulent form at another; but it is much more probable that the disease has never been fully understood, especially with regard to its palliatives and remedies.

Mr. Perrin's introduction to this edition gives in small space a good deal of new and interesting information about both the book and its author. On one point only criticism seems necessary. Mr. Perrin, in noticing the largeness of the sum paid by Shelvocke in China for customs dues, comments on its disproportion to sums paid at the same time by other ships, and inclines therefore to the conclusion that Shelvocke was presumably on this account a rogue as he must have pocketed the difference. But this explanation neglects the important factor that a customs official had been murdered by one of Shelvocke's men. In such a case it would be almost inevitable that the authorities should see their opportunity for exaction.

It seems at first sight more than curious that the economic discoveries made by Shelvocke, of the Southern whale fishery, of Californian gold, and of the guano islands, should have passed unnoticed. There can be little doubt that, had Shelvocke come home at about the time he went out, any or all of these discoveries would have readily attracted the capital necessary for attempting to exploit them; but the disastrous financial history of 1720 had intervened, and no distant and expensive venture, more especially in the South Seas, stood any chance of support. L. G. C. L.

EXCAVATIONS IN MALTA. By M. A. MURRAY. Part III, with a chapter by C. AINSWORTH MITCHELL and THOMAS J. WARD. *London: Bernard Quaritch* 1929. 11×7 *inches;* xxxv+38 *pages; illustrations.* 7*s* 6*d*

In this volume Miss Murray supplements the previous accounts of her excavations at Borg en Nadur in Malta by describing the results of the work carried out in 1926 and 1927. The main enclosure was further explored, and the excavation of a building to the south-east proved it to be a double chapel, enclosed by a limiting stone wall. The chapels are situated east and west, the western one being in a very ruinous state. Each of them was entered through a trilithon, that at the entrance to the eastern chapel being one of the finest in the island. Much pottery was found, extending down to within a foot of the rock floor. It was all of Bronze Age except for a few Neolithic shards in the lowest level. Like the pottery found elsewhere in Borg en Nadur it was in a very broken state, but two almost complete vessels were discovered in the space between the eastern chapel and the limiting wall. The feature of the book are the excellent plates, thirty-five in number. They show photographs of the most recent excavation, and a large number of illustrations of pottery, chiefly of the Bronze Age, also of flint implements and stone objects. Very few metal objects have been found. Those figured are of bronze, and include what look like a pair of bracelets, a Phoenician coin of the third century B.C., and a piece of bronze of indeterminate shape, but of much interest if the author's inference is right that it is the overflow from round the pouring hole of a casting, for it would show that the inhabitants at this time were metal casters. This conclusion is supported by the discovery in one of the chapels of a small limestone mould for casting metal. This is the only casting mould of the period that has yet been found in Malta.

The most curious pottery objects are anchors. One of the plates gives all the

examples yet found in Malta. They have been discovered on only two sites, Borg en Nadur and Bahria. Miss Murray suggests that as the absence of good landing-places on the south coast renders it very dangerous to mariners in stormy weather, they might express their gratitude after safely weathering a storm by offering an anchor in the temple of the god. Some ingenious suggestions are offered with regard to dating based on the arrangement of the buildings, pitting of stone, and on the shape of the sacred pillars in the megalithic temples.

Appended are analyses, chemical and microscopical, of the earths from the excavations by Mr. Ainsworth Mitchell and Mr. T. J. Ward; plans of Borg en Nadur, Tarxien, Mnaidra, and Corradino; and an index. The author, by the publication of this third volume, rounds off in a most satisfactory way her interesting researches in Malta. E. A. P.

THE LAND OF THE LAMA. By DAVID MACDONALD. *London: Seeley Service & Co.* 1929. 9×6 *inches;* 283 *pages; illustrations and a map.* 21*s*

The author, from sixteen years' residence in the land which he describes, and through his personal friendship with the present Dalai Lama, has every reason to claim our confidence in his presentation of an interesting and well-described subject. Many of us can remember him as an *attaché* to the political staff of Sir Francis Younghusband during the 1904 Mission, when his intimate knowledge of the people and their language was fully utilized. He has here arranged his subject into logical sub-heads, in clear and unambitious language which carries us on from one interest to another and leaves us, in the end, hardly less impressed with the author's intimate knowledge than with the peculiar facts which he describes. The remoter history of Tibet should be an engrossing subject, and should fill in for us a lacuna in the records of a land surrounded by other countries whose histories are verifiable and exhaustive. Unfortunately, it seems to follow the usual school-book practice of relating the doings of kings and queens, which the author has found himself compelled to record; and, when treating of the importation and spread of Buddhism, he hardly makes enough of the fact, which he takes in his stride, that Buddhism, in ousting the Bon Shamanism of great antiquity, paralyzed the fighting powers of a race which had, till then, been the terror of its neighbours; very much as the Mongolia of Genghiz Khan and Kublai has been emasculated in more recent times. But, in his descriptions of the doings of the people at the present day, he is on surer and more interesting ground. Perhaps the most engrossing portion of the book is chapter v, wherein the whole lamaist pantheon is laid out for us to investigate and appraise. The extraordinary multiplicity of godlings, and those specialities of lamaism, the "canonized demons" or evil spirits which, by magical incantations, have been suborned in the interests of the human race and made to turn traitor to their fellow-demons; these are classified and sub-classified according to rank, potency, characteristics, and even locality, till the head swirls. Here, if nowhere else in the book, do we get the full advantage of that "certain measure of consanguinity" of the author with his people, of which Lord Ronaldshay so appreciatively speaks in his foreword. The plain Scottish chronicler could never have drawn for us so vivid a picture; nor would he have been capable of the expounding of the Wheel of Life which, in such intelligible detail, we now read for the first time.

Chapters xi and xvi, dealing with the macabre, are the only unpleasant portions of a book which would otherwise have left us with the impression of a friendly and blameless people. This, and the statement that the *Ovis poli* is to be found in Tibet, are the only two details in which we quarrel with the author, whose book may be taken as a final brushing aside of the veil surrounding a mysteriously

exclusive land—a veil first lifted for us by Sir Francis Younghusband. Though one of the last surviving enigmas of the world has vanished, we may forgive the author for having removed it by the account which he has given us. Illustrations, map, and index complete a thoroughly satisfying book. L. A. B.

VOYAGES OF GREAT PIONEERS. Edited by VINCENT T. HARLOW. *Oxford University Press* 1929. 7×5 *inches;* lv×380 *pages; illustrations.* 6*s; in two parts,* 3*s* 6*d each*

Mr. Harlow is known as a student of the history of Elizabethan discovery and early colonization, and the contents of this volume of extracts illustrates his predilections. Five out of the ten voyagers whose adventures are described are Englishmen, and four of these are Elizabethans. In his introduction he gives a good general sketch of the advancement of world-knowledge, making plain how it came about that the precursors of the great voyagers were the travellers represented here by Marco Polo and William of Rubruck. Of all these "great pioneers," William reveals himself in his narrative of his sojourn among the Tartars as the most engaging personality. The accounts of Columbus's first voyage and Da Gama's first voyage to India follow. Mr. Harlow's plan throughout is to concentrate upon accounts of countries and peoples rather than upon adventurous incidents. Thus the Elizabethan section contains, in addition to voyages of Frobisher, Drake, Raleigh, and Lancaster, extracts from Sir Humphrey Gilbert's 'Discourse' on the North-West passage, and an account of the Massacre at Amboyna, which seems to have small claim to inclusion. The book is completed by Tasman and Captain Cook. The latter is represented by his accounts of New Zealand and Australia; the adventures of the *Endeavour* off the Great Barrier Reef are not related. Several statements in the Introduction, particularly in the later paragraphs, might be questioned. The phrase "with all his guess work" applied to Ptolemy is misleading. There is no reference to the pioneer work of the French, a realization of which would have modified the statement that "England was the first to challenge the monopoly claimed by the Spanish Colossus." The concluding portions of the Introduction would have been made clearer by a brief explanation of the conception of a great Antarctic continent. This was not, as Mr. Harlow states, evolved for the first time by sixteenth-century geographers, but was in part inherited from classical times. He also comments that "Even Tasman failed to prove that the latter (Australia) was an island"—surely a slip for New Guinea? Just as Drake proved that Tierra del Fuego was not part of this hypothetical continent, so Tasman showed that Australia also was detached from it. Cook later did the same for New Zealand, and reduced the conception within much more modest limits by his voyage below the Antarctic Circle.

These are however small points, but there are several slips in the short bibliography, the most troublesome of which is probably the misprint of "K. G. Gayne" for "K. G. Jayne." A legend beneath an illustration implies that Marco Polo left Venice in 1338. G. R. C.

THE PAGANS OF NORTH BORNEO. By OWEN RUTTER, F.R.I.A. With an Introduction by C. G. SELIGMAN, F.R.S. *London: Hutchinson & Co.* 1929. 7×10 *inches;* 288 *pages; illustrations, diagrams and two maps.* 30*s*

Mr. Owen Rutter possesses two qualities that do not always coexist in writers on primitive peoples of the remote corners of the Earth. One is an intimate and sympathetic knowledge of his subject, and the other a turn of literary sense and style that enables him to impart pleasure to his readers at the same time with instruction. He has written much of British North Borneo, and in this, his latest

book, he returns to that field and, passing from the general to the particular, essays with much success a detailed study of the Animist tribes that form the greater part of the population of that sparsely inhabited region.

The author modestly remarks in his preface that, feeling himself imperfectly equipped for his task, he had hoped to have as collaborator Captain A. B. C. Francis, an officer of long service with the British North Borneo Company; but that Captain Francis died before the combination had done more than break ground, and left him to execute the work alone or to abandon it. Fortunately Mr. Rutter decided to carry on, and, with assistance from other erstwhile colleagues of the Company's service, assistance scrupulously acknowledged both in preface and context, he produced in due course this notable work.

Of the many Animist tribes of Indonesian and other stock that inhabit the Island of Borneo, the Murut and Dusun occupy the northern corner, or British North Borneo, and to these the author confines himself entirely. He describes the tribes as they exist to-day and scarcely touches on the vexed question of their origin, adopting without discussion the theory most in favour at the moment and only stepping aside to demolish with excusable heat certain far-fetched arguments favouring a Chinese ancestry for the Dusun tribes. The matter of origin, however, is expanded by Professor C. G. Seligman, who explains the favoured theory and supports it with references to Doctors Haddon and Hose and McDougal in the Introduction which he contributes to the book. This Introduction, by the way, refers more than once to "The Pagan Tribes of Borneo" of Hose and McDougal, thereby emphasizing the curious fact that, while gleaning freely amongst books concerned with Borneo, Mr. Rutter rules out this monumental classic and passes it by in a silence that amounts almost to perversity.

The whole population of British North Borneo is about 200,000, of whom some 137,000 are Animists, and these are divided into a series of twenty-five groups, with the wildest and most primitive Murut of the interior highlands at one end of it, and the most enlightened and sophisticated of the plain-dwelling Dusun at the other. Fundamentally, the general characteristics, social organization, arts, agriculture, tribal laws and religious beliefs of all the tribes are very much alike, and Mr. Rutter deals with each of these subjects in a single chapter; but many differences exist, and all such, whether major or minor, are carefully noted and elaborated. The differences concerning agriculture are perhaps as great as any, some tribes having practically none at all, while others own settled lands and practise farming by the most approved Far Eastern methods, inspired by Chinese or, more probably, by Philippine influences.

Mr. Rutter took part in the final suppression of head-hunting in British North Borneo and has a good deal to say of this once widespread and honoured custom. He produces at length, with full translation and notes, a triumphal chant of successful head-hunters and their women and a list of "tabu" to be observed by women while their men are on the war-path, both of which are of ethnological importance. The whole work, and especially the part comprising an able disquisition on tribal law, bears the imprint of careful thought, and though, as is inevitable, it repeats a good deal that has already been given to the public by earlier writers on the Borneo tribes, it contains enough new matter to ensure its reception as a momentous contribution to Oriental anthropology.

On reading the book the student of Far Eastern races cannot fail to note the almost exact similarity between many Murut and Dusun customs and those of their cousins in Dutch Borneo and Sarawak; and also the striking resemblances with those of their far more distant relatives in various parts of the Further Indian mainland. For the methods of food-getting, fighting and love-making, the super-

stitions, incantations, dances, feasts, and drinking bouts here so graphically described, are common to all the wild men of Borneo and have their close analogies on many a hilltop in the vast area that lies between Sikkim and Saigon.

A comparative vocabulary is given as an appendix. Many of the words seem at first sight to have come from the Malay or the Philippine languages, but when it is seen that these same words mostly refer to fundamentals, *e.g.* birth, death, eating, sun, moon, stars, blood, etc., it is recognized that they must derive from far older sources, the Indonesian, Polynesian, stocks from which have sprung the languages of Java, the Philippines, Malaya, and so forth. For this reason the vocabulary is of the greatest interest.

This is the second time since Skeat and Blagden adopted it, that the word "Pagan" has been used on a title-page to denominate the Animists of Further India and the Archipelago. Specious explanations notwithstanding, the term must always bear a derogatory significance, and, as such an implication does not seem at all necessary, it may be hoped that some day a writer of imagination will arise who will find a new appellation for these interesting tribes.

Mr. Rutter's work is presented in one volume, perhaps a trifle large for convenience, with clear type, illustrations from photographs, the difficulties of obtaining which atone for their occasional imperfections, a serviceable map, and a full index. W. A. G.

SAID BIN SULTAN (1791–1856): Ruler of Oman and Zanzibar. His place in the History of Arabia and East Africa. By RUDOLPH SAID-RUETE, with a foreword by Sir PERCY COX. *London: Alexander Ouseley* 1929. 10×6 *inches;* xviii+200 *pages; illustrations and sketch-maps.* 16*s*

This valuable and in some respects unique work is a serious contribution to British and French colonial history during the period with which it deals. Though the author, himself a grandson of Said bin Sultan, relies of necessity almost wholly on contemporary British, French, and German records for his facts, he has succeeded remarkably well in writing in a spirit of filial piety an impartial narrative rather from the point of view of the subject of his memoir than from that of a European observer. The arrangement of the material is clear, the documentation ample, and the footnotes often of much interest; there is an ample though incomplete bibliography.

Said bin Sultan was in all respects a remarkable man, who combined diplomatic and strategical skill, qualities not uncommon in Arab rulers, with the rarer gifts of commercial acumen and consistency of motives, plan, and execution. He succeeded to the leadership of a congeries of weak and disunited tribes: he left behind him in Oman a prosperous cohesive state, and founded in Zanzibar an overseas Dominion more valuable by far than Oman in terms of commercial wealth, and we may well agree with the terse verdict of Burton, "Seyyid Said was probably as shrewd, liberal, and enlightened a prince as Arabia ever produced." Though the journey from Muscat to Zanzibar in his day involved a sea journey of six weeks, he contrived to maintain personal rule in both continents, to keep Wahhabis, French, and British and Persian ambitions alike from endangering the independence of his kingdom, and withal to cooperate actively with Great Britain in the suppression of the slave trade. This last achievement is the more creditable to him since no other independent Eastern country had hitherto accepted the British ethical stand-point in regard to the traffic, which was actively encouraged by the French, who, as a matter of fact, have always been backward in giving effect to the provisions of the Brussels Conventions on the subject. That neither our efforts nor those of Said bin Sultan were immediately successful is immaterial: the first and most difficult step was taken by him

when, in defiance of popular opinion, he undertook to cooperate in the suppression of a trade which had the sanction alike of antiquity, of the Koran, and of the greater part of the Eastern world.

The book is well indexed and includes several apposite illustrations: it is well printed, though to print important proper names in full capitals in text and notes does not improve the appearance of the page; there are numerous small misprints, and the author appears to have followed no particular system of transliteration; but these are trifling blemishes in a book of unusual interest and value to students of Eastern history. A. T. W.

HANDBOOK OF COMMERCIAL GEOGRAPHY. By G. G. CHISHOLM. Eleventh edition, revised and edited by L. D. STAMP. *London: Longmans, Green & Co.* 1928. 9×6 *inches;* xvi+826 *pages; diagrams and maps.* 25*s*

The revision of a work which has already become a classic is a very difficult task for any editor, and Dr. Stamp deserves well of geographers for the skill and care with which he has done his work. A comparison of this with the last edition fully bears out the statement in his preface, that the changes needed to bring the text up to date have demanded additions or modifications in almost every paragraph; but it should be said that very few of these alterations are obtrusive—he has succeeded in welding the new to the old with almost invisible joints—and this edition will maintain the work as our standard treatise on its subject.

The editor's choice of 1924 as the typical post-war year for the comparative tables of foreign trade (Appendix) is open to discussion. It is undoubtedly true, as he states (p. v), that no other post-war year is better, or perhaps equally suitable, for the purpose. But this work is published four years after 1924; and the choice of that year means that a supplement with comparable figures for a later date is already needed. The disturbances caused by the War have made it more difficult than it was before to obtain any useful averages to correspond to, and compare with, those of the five-year periods used in summarizing pre-war statistics. It may be that the very disturbed conditions of recent years lead us to underestimate the disturbances of the pre-war periods and to regard the nineteenth century as calmer and more stable than it actually was. All the long-period studies of commercial movements before 1914 were subject to disturbing fluctuations due to wars in some part of the world; and although the World War of 1914–18 was enormously greater than any of its predecessors it seems that comparable studies should not be much longer postponed, even though the task is now more formidable than before, because of the steady growth in the magnitude and complexity of commercial intercourse as well as because of political changes and complications.

In reviewing a work of this magnitude it is possible to refer to only a few of the innumerable statements on matters of fact. In note 2 on p. 333 it is said, rightly, that it would be futile to comment on population changes in British cities on the basis of the census figures for municipal areas. A preliminary study of the grouping of these areas into conurbations, or urban aggregates, which might be of use in preparing the next edition of this work, appeared in the *Sociological Review* for April 1922. Some recent advances in fuel-chemistry have made statements on p. 341 no longer wholly true. It is now practicable to produce a satisfactory iron-smelting coke from Cumberland coal, and coke-ovens at Aspatria were working in 1927. On p. 351 there is a mistake in describing the position of the Roman predecessor of Southampton—the remains of Clausentum are on the east bank of the Itchen. And on p. 298 the Leeds and Liverpool Canal is apparently confused with the Aire and Calder Navigation—the latter does not cross the Pennines, but connects the West Yorkshire coal-

field with Goole on the Humber. Here also the next revision of the map (p. 299) will show the improvement of the River Trent up to Nottingham. The interesting comparison between Australia and South Africa (pp. 679–80) is an example which might well be followed more often if space would permit. In this case we may suggest that a comparison, for corresponding latitudes, of the extents of land at high altitudes in these countries is of special importance near to and within the tropics: such a comparison might usefully be extended to include Southern Brazil, and be illustrated by one or more of the diagrams which the editor hopes to add in future editions. C. B. F.

THE STATESMAN'S YEAR-BOOK: Statistical and Historical Annual of the States of the World for the Year 1929. Edited by M. EPSTEIN., *London: Macmillan & Co. Ltd.* 1929. 7 × 5 *inches;* xxxii + 1448 *pages;* 2 *maps.* 20*s*

There can be very few statesmen who, as questions of fact are showered upon them, do not take refuge under the spreading branches of this well-grown tree. It has now reached the respectable age of two-thirds of a century, and the imposing stature of close on one and a half thousand pages. The index alone runs to a whole hundred; of the remainder the British Empire claims 430, the United States 200, and Other Countries 720, while the xxxii Introductory Pages deal with such matters as world-statistics and the League of Nations. There are even a couple of pages bringing this most up-to-date publication more up to date still. We are told here, for example, that Fengtien Province (Manchuria) has been renamed Liaotung (Liaoning according to the *Geog. Journ.* for July); there is, however, no reference to the new names of Chihli Province and Peking. It is surprising what an amount of information is forthcoming about a country like China in her present state; receipts and disbursements of the National Government are given to the nearest dollar, *e.g.* expenditure on agriculture and mining, 41,799 dollars. No such figures, of course, are available for Afghanistan. The introduction of a Latin alphabet in Turkey is mentioned; but the Turkish name of the country as given is not according to the new orthography. It is strange to see French "Cameroon," but British "Cameroons"; the former spelling belongs to no language. We should have expected to find lists of provinces in countries like Nigeria and the Sudan, as we have these particulars for Egypt and even the complicated divisions of the U.S.S.R. This last is placed under R, though Russia is now nominally but one of six republics forming the Union. It is curious, by the way, not to find the name Stalin anywhere. Iceland is placed next to Denmark, though it is now a sovereign state and as much entitled to occupy its proper place as 'Iraq or Rome (See and Church of), which, be it noted, has a special coloured map to illustrate the boundary according to the Treaty of February 1929. There is another coloured map showing the Colombia–Peru Boundary Adjustment of December 1927. One of the outstanding features of the 'Statesman's Year-Book,' and that probably most consulted at the Society's House, is the admirable bibliography given with every country, and sometimes, as in the case of Germany, with every component state. The books of reference about China occupy four pages of small type, while the Panama Canal has a list nearly three-quarters of a page long. Here certainly is an Epstein masterpiece, the merit of which is beyond controversy.

J. H. R.

THE MONTHLY RECORD

AUSTRALIAN ANTARCTIC RESEARCH EXPEDITION

To supplement the notice of this expedition published in the *Journal* for July, it is a pleasure to record the generous gift of £10,000 to the funds of the expedition made by Mr. Macpherson Robertson of Melbourne. As no general appeal for funds was made to the public, the organizers of the expedition are all the more grateful for this substantial contribution and for the gifts of other private subscribers who are assisting the venture. The *Discovery* left Cardiff on August 10 for Cape Town, where she will pick up Sir Douglas Mawson and other members of the expedition, before proceeding to Hobart, Tasmania, her last port of call before entering Antarctic waters.

THE SHANNON HYDRO-ELECTRIC POWER-SCHEME

The first stage in the completion of the Shannon hydro-electric scheme was marked by the admission of water into the head-race on July 22. Power should be available before the end of the year. A general description of the scheme and its economic bearings is given by Mr. George Fletcher in the *Journal* of the Royal Society of Arts (77, pp. 478–96), and the technical questions have been discussed from time to time by Capt. C. C. S. White in the *Royal Engineers' Journal* (June 1927, Sept. 1928, March 1929). The first problem lay in securing a sufficient fall on the extremely level course of the Shannon: above Killaloe it falls 55 feet only in 125 miles, but between Killaloe and Limerick the fall is 90 feet in 15 miles. Accordingly the basis of the scheme is the diversion of part of the river below Killaloe along an approximately level canal 7½ miles long (the head-race) to Ardnacrusha, where a fall varying from 86 to 115 feet is obtained. Under the partial scheme at present contemplated, the necessary storage of water against the low season can be obtained by lowering the level of Lough Derg by 2 feet in the summer. The ratio between maximum and minimum flow is 33 : 1. The work includes, therefore, the protection of the Lough and river-banks from flooding. At Parteen Villa a weir has been built across the Shannon bed to control the flow into the head-race, which raises the river-level 23½ feet. This weir is built into the underlying Old Red Sandstone: some trouble was experienced from fissures in the rock, but this has been overcome by forcing in liquid cement under pressure. The design of the spillway, constructed in Wicklow granite, will minimize as far as possible the chances of great changes through erosion in the lower river-bed. Alongside the weir water is admitted to the head-race through the Intake station; this is also provided with a lock, as navigation will be confined to the head-race for this section. The head-race has a maximum depth of 37 feet and width of 297 feet; it is crossed above by three bridges and below by siphons carrying the natural drainage of the area. The Power Station at Ardnacrusha rests upon blue limestone: a pocket of earth had to be partially removed and replaced by concrete to prevent the foundations cracking. The concrete dam, 123 feet high, and about 300 feet long, has three openings (to be increased to six on full development): from these penstocks, steel pipes 20 feet in diameter, lead the water, after being cleansed from débris, to the turbines. The water is then returned to the tail-race and finally to the Shannon. Two locks are also provided, and the tail-race is designed to check the velocity of the water, to prevent navigation being impeded. A broad-gauge railway connects the power house with the Great Southern system. The turbines are of 38,600 h.p. each, coupled to alternators generating electrical energy at 10,500 volts. For distribution, the current is stepped up to 110,000 volts and carried to Dublin and Cork by high-transmission lines, distances of

116 and 59 miles. It will then be transformed, and pass through a secondary loop distribution of over 1000 miles to all parts of the country. The power thus provided, besides assisting agriculture and rural occupations, will remove the handicap to industrial development due to the absence of coal supply, a development which it may further assist when applied to the production of peat fuel. The total cost of the scheme is approximately £5,000,000; of this £2,500,000 is the cost of regulating and engineering works, £500,000 that of the machinery at the power-house and elsewhere, while £2,000,000 is being expended upon the transmission.

STUDIES OF MEAN SEA-LEVEL

During the last two years studies of mean sea-level have been carried on in New York waters, under the direction of the Division of Geology and Geography of the National Research Council of the United States and under the immediate inspiration of Professor Douglas Johnson, who had kindly sent us a preliminary statement of the results. The object of the investigations was to test the theory advanced by Professor Johnson, that along an irregular coast mean sea-level is an irregular surface the precise elevation of which varies with changes in the form of the shore. The work, carried through in co-operation with the U.S. Coast and Geodetic Survey and other organizations, has recently been completed and a full report will shortly be published. Jamaica Bay was selected for the study partly because the breadth and depth of the inlet were believed to be sufficient to admit tidal waters freely, while the relatively small size of the bay, with its marshes and mud flats, would prevent the water on entering from spreading too far. The main results of the observations to be described in the report may be summarized as follows: (1) The tidal range within the bay was found to be greater than at Fort Hamilton, near the head of the more open Lower (New York) Bay; (2) mean sea-level at all three stations in the bay is higher than at Fort Hamilton, due, Professor Johnson believes, to a combination of causes: the shape of the inlet channel; the partial impounding of fresh water entering the bay and the greater density of this water; the action of westerly winds, to which Jamaica Bay is more exposed than Fort Hamilton; and the configuration of the shore-line and of shoals and islands in the bay; (3) within the bay the plane of sea-level is higher at the north-eastern than at the southern and western stations; (4) observations at Fort Hamilton over a thirty-five year period (1893–1927 inclusive) indicate no appreciable change in sea-level at that station and afford no proof of any progressive change in the general level of land or sea. Professor Johnson feels that the results from Jamaica Bay support the view that distortions of the mean sea-level plane may be inferred from a consideration of the physiography of a given shore-line, and that much greater distortion must exist at many points along the coast, with smaller distortions in some bays and harbours widely open to the sea.

THE IMATONG MOUNTAINS, SUDAN

Just north of the Uganda–Sudan boundary there is an isolated group of mountains, rising in its highest peak, Mount Kineti, to over 10,000 feet. It is one of the series of similar rocky upthrusts which rise abruptly out of the plains, and form, as it were, stepping-stones between the East African Mountains, the Abyssinian Highlands, and the Mountains of Darfur and the Sahara. Little has been known of the vegetation of the higher summits, and the results of a recent visit by Major Chipp of Kew, described in the *Kew Bulletin* No. 6, 1929, are thus of much interest, for they supply a new northern record for the mountain flora of Equatorial East Africa, and a further link with the vegetation

of Abyssinia and the mountains of Equatorial West Africa.* The mountains were reached from the west, the intervening plains being crossed by motor from Rejaf on the Upper Nile. The motor track ends near the base of the foothills, and here the first piece of Closed Equatorial Forest seen on the whole journey from Egypt was met with. The further route followed the line of villages along the sides of the Acholi Hills, the natives now living above the 4000-feet contour as a measure against sleeping sickness, which seems to have proved effectual; they go down to their farms daily. A digression southward, which led through a tract of tufted bamboo and later through one of tall grass-woodland enlivened with flowers, brought the party to a basin filled with closed forest in which wild coffee trees were in full bloom, their pure white flowers making a lovely sight. The steep ascent to the high plateau was trying, but on reaching the mountain vegetation at 8000 feet an invigorating wind made matters easier. The final ascent of Mount Kineti revealed a further succession of vegetation zones, the affinities of which, as also of those passed at lower levels, are sketched by Miss M. B. Moss of Kew on the basis of the collection brought home. Besides herbaceous species of wide distribution the fire-swept grass-woodland (2000–4000 feet) contains a few trees found also in West Africa, with others distributed north and south from the Sudan to Rhodesia. In the closed equatorial forest (4000–5000 feet) many of the species are local or have a remarkably disconnected distribution. The next belt, the fringing forest, consists mainly of typically East African plants. Another belt of grass-woodland extends to 8000 feet, above which are mountain ravines with the conifer *Podocarpus Milanjianus*, found also on Mount Milanji in Nyasaland, and as far south as Gazaland. Both here and in the mountain meadows above, representatives of the Northern and Southern floras meet, and the plants of the actual summits show similar affinities.

JOURNEY DOWN THE WEBE SHEBELI

A short preliminary account of a recent journey along the entire course of the Webe Shebeli is given by the Duke of the Abruzzi in the *Bollettino* of the Italian Geographical Society for June 1929. The purpose of the expedition, which received support from the Abyssinian and Italian Governments and scientific bodies, was to map the course of the river, to collect hydrological information, and to ascertain whether there are peoples with Somali affinities who might be settled along the Somaliland portion of the river. Frequent latitude observations and longitude determinations by wireless time-signals were made by Messrs. F. Palarrolo, G. Braca and O. Pavanello. The party left the Addis Ababa railway at Hadama late in October 1928, and pushed through the Arusi massif east of Lakes Zwai and Shala to the source of the river in the Sidamo district. This portion of the journey was the most arduous, through the inclement weather and the extremely broken nature of the country. The river descends from the mountains in several falls, and some distance above Sheikh Hussein has carved a deep cañon. At this town camels were obtained in place of mules, for the more arid stretches of the middle Shebeli. The river derives most of its water from the heavy rains which fall from June to November with brief interruptions, so that despite the conditions of its lower course it rarely dries up completely during its lowest month—April. The party reached the Somaliland boundary at the beginning of February, where motor transport

*Major Chipp refers to the map given with Mr. Arnold Hodson's paper in the May *Journal* as the first to show these mountains, having apparently overlooked the earlier account (with map) by Mr. H. P. Wright in the *Journal* for October 1917 (vol. 50, p. 283).

awaited them for the final stage. In addition to the cartographical and hydrographical work, mineralogical, ethnological and biological researches were prosecuted, the results of which are to be published soon.

CENTENARY OF STURT'S DISCOVERY OF THE MURRAY

Captain Charles Sturt, perhaps the most noted of Australian explorers, started on the second of his three great expeditions, on which the course of the Murray river was discovered, in November 1829, returning to Sydney, his starting-point, in May 1830. Arrangements have been made in Australia for a celebration of the Centenary of this great achievement, by which the main outlines of the greatest Australian river-system were for the first time clearly established, and we have received details of the programme both from the President of the South Australian Branch of the Royal Geographical Society of Australasia and from Mr. A. Grenfell Price on behalf of the South Australian Historical Memorials Committee. The Governor of South Australia, Sir A. Hore-Ruthven, will proceed in October to Renwark, near the New South Wales boundary, and will descend the Murray by steamer, unveiling in succession a series of memorials erected at the expense of the local authorities at various historic points along the route. Inscriptions on these will give the dates of Sturt's arrival at the places of erection. The principal monument is at Hindmarsh island, near the mouth of the Murray, where Sturt first saw the ocean on the completion of the downward voyage. It is a column 40 feet high with a bronze tablet suitably inscribed. The Committee has the support of the Government, and a map illustrating the historic voyage has been prepared by the Survey Department with notes on the back by Mr. Grenfell Price, giving a sketch of Sturt's career, and of the subsequent development of South Australia and of the modern utilization of the Murray for navigation and irrigation. It may be recalled that Sturt, who in 1828–29 had discovered and named the Darling, set out a second time with a land party to trace the Murrumbidgee to its termination. By a sudden change of plan he decided to continue the exploration by water, building a whale-boat and skiff in which the tedious and dangerous navigation of the rivers was completed, the return voyage upstream entailing the greatest hardships and nearly ending in disaster. Sturt's work on this journey was continued by his brother officer, Capt. Collett Barker, who surveyed the Gulf of St. Vincent and discovered the Port Adelaide inlet, thus helping materially, with Sturt, to the subsequent foundation of the colony of South Australia.

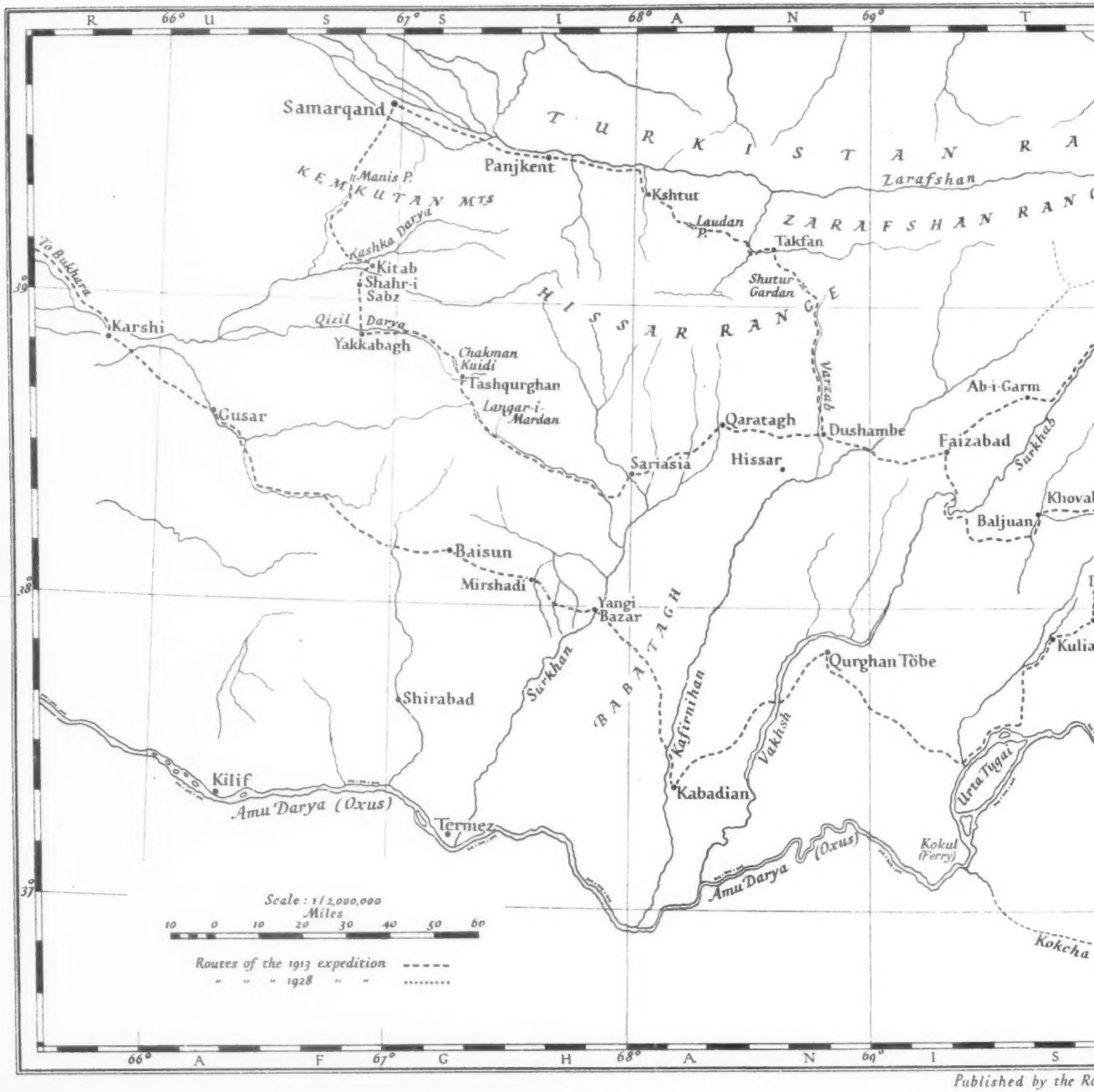
THE CONTINENTAL DRIFT THEORY

All who are interested in this much-discussed theory should read the admirable summing up of the question by Prof. Arthur Holmes in the *Mining Magazine*, April to June 1929. The writings examined include, besides those of Wegener himself, those of Du Toit and Taylor (who had to some extent anticipated the views of the chief champion of the theory), of the several contributors to the symposium lately held in the United States (see *Journal*, 73, p. 570), and of noted geophysicists like Joly and Jeffreys. Prof. Holmes subjects the views of each to careful analysis, and, by skilfully piecing together those which stand the test, arrives at conclusions which go far to carry conviction. The earlier sections summarize the main points of the theory and show that some at least of the criticisms launched against it are devoid of real force, while the parallels between the two sides of the Atlantic both from the tectonic and mineralogical points of view are so remarkable and even startling as to be very strong arguments for a former closer union. But the writer is far from following

Wegener in matters of detail. With Du Toit he rules out actual former contiguity of the present continental borders, the distance being regarded as probably never less than 250–500 miles, with an intervening space mainly continental. On the other hand, it is pointed out that those who uphold the more orthodox geology must face geophysical difficulties as serious as are encountered by those who believe in continental drift. Modern ideas of crustal structure and isostasy are held to be quite incompatible with the view that the Atlantic has been formed by inbreaking, for it is at least as difficult to sink continents as to tear them forcibly apart. Again, the later Carboniferous glaciations of Gondwanaland cannot be satisfactorily explained by the opponents of the drift theory, and even Brooks is not satisfied that his purely geographical solution explains the glaciation of India.

Prof. Holmes allows that Wegener's discussion of the mechanism of drift, and of the mountain-building therefrom resulting, is on the surface inconsistent, for if the *sima* (the heavier substratum of the crust) be without strength, the advancing *sial* could not be crushed against it. But he points out that the mountains of Western America represent not sial crushed against sima, but a vast geosynclinal belt of sediments crushed between two relatively approaching jaws of sial. In regard to a possible means of "engineering" the drifting process Prof. Holmes points out that the contrast between sial and sima may explain not only the two dominant levels of the solid surface, but also the marked departures from those levels. Compression and overthrusting lead to the uplift of plateaus and mountain ranges when acting on deeply sedimented beds of sial; and to equally marked subsidence (producing oceanic deeps) when acting on sima. By sinking into the substratum this would make a way for continents to advance. Support for this view is found in the remarkable picture of the structure of Asia put forward by Argand, the supposed underthrusting of Asia by Gondwanaland explaining the mysterious disappearance of the Oman Arc (which has been held to militate against Wegener's views) and the almost incredible northerly drift of India, as shown by its Carboniferous glaciation.

Wegener is held to have been mistaken in insisting too strongly on a general westerly direction of drift, the more probable conclusion being that the two old masses of Laurasia and Gondwanaland were broken up with radially outward drifts of their parts towards the Pacific and the Tethys, leaving behind the disruptive basins of the North Atlantic and Arctic Oceans on the one hand, and of the South Atlantic, Indian, and Southern Oceans on the other. In the final section of the paper Prof. Holmes suggests as a possible cause of drift the generation of powerful convection currents beneath each great land-mass, such currents being started by the generation beneath the continents of more heat than can escape through the overlying rocks by conduction, while each part of the mass would be enabled to move forward by the fracturing and foundering of the heavy ocean floor immediately in front. But it is admitted that the further general drift of the whole crust over the interior (with a marked northerly component on the African side) which seems called for, cannot be quite so easily explained.



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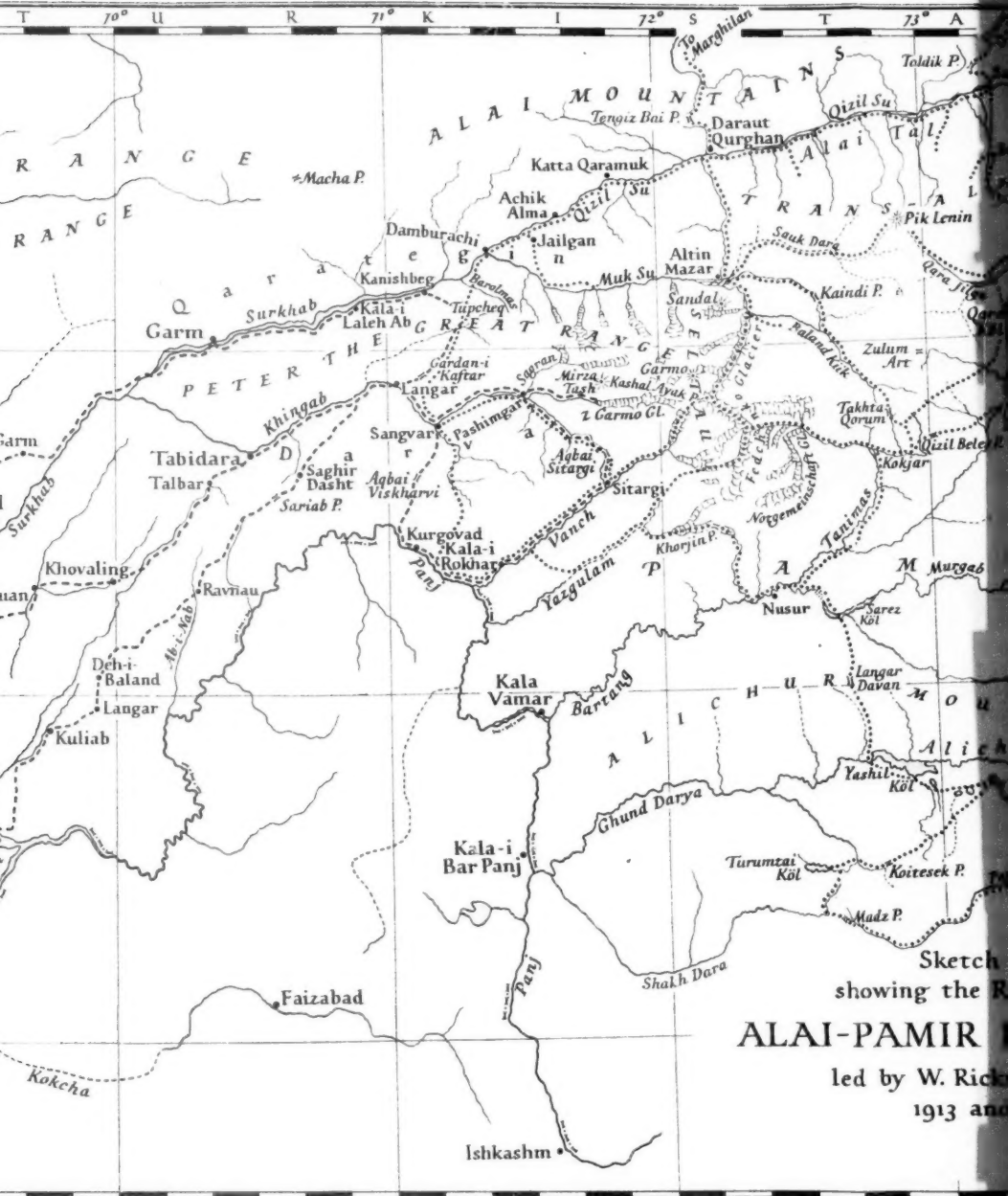

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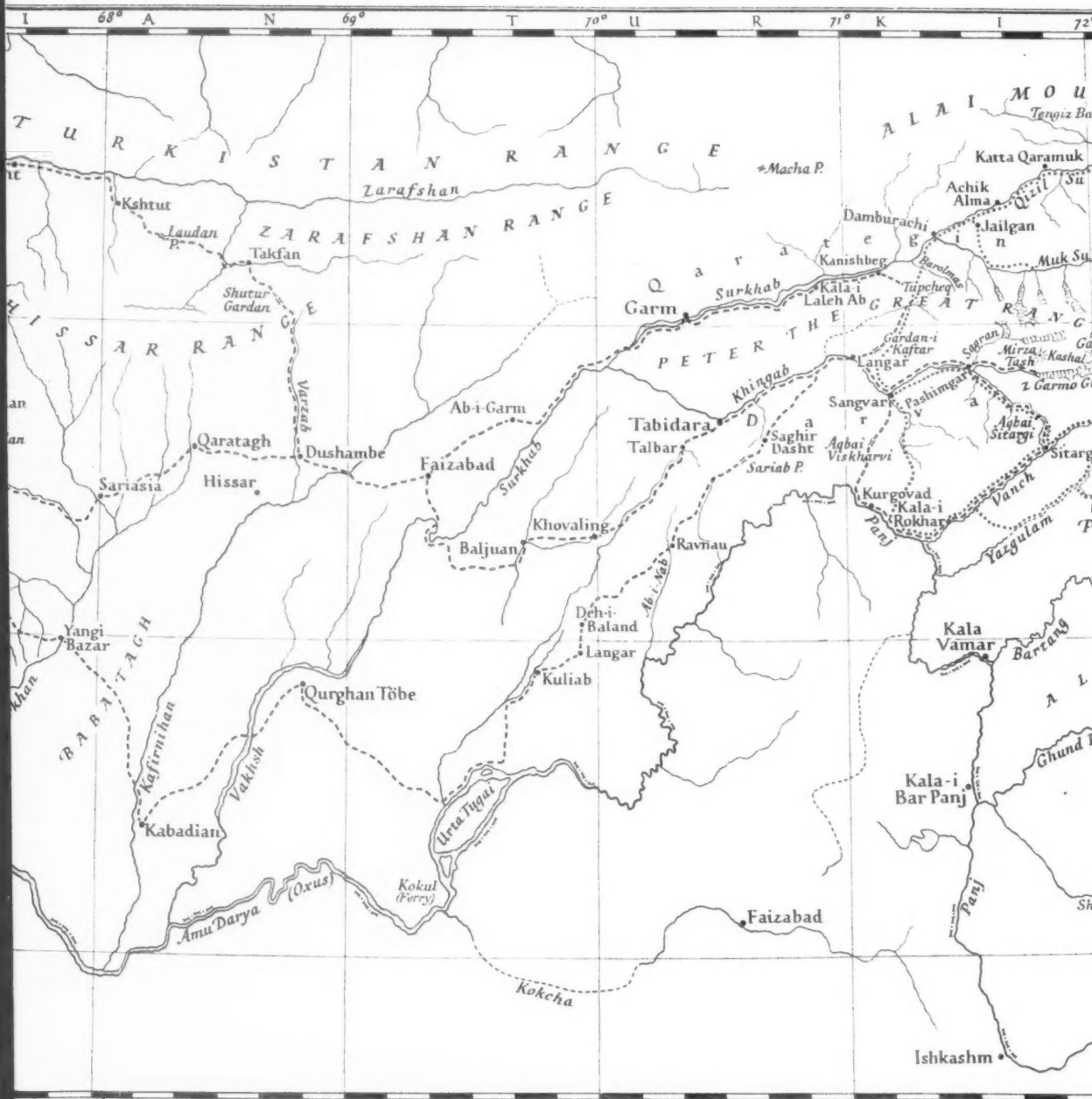

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Sketch Map
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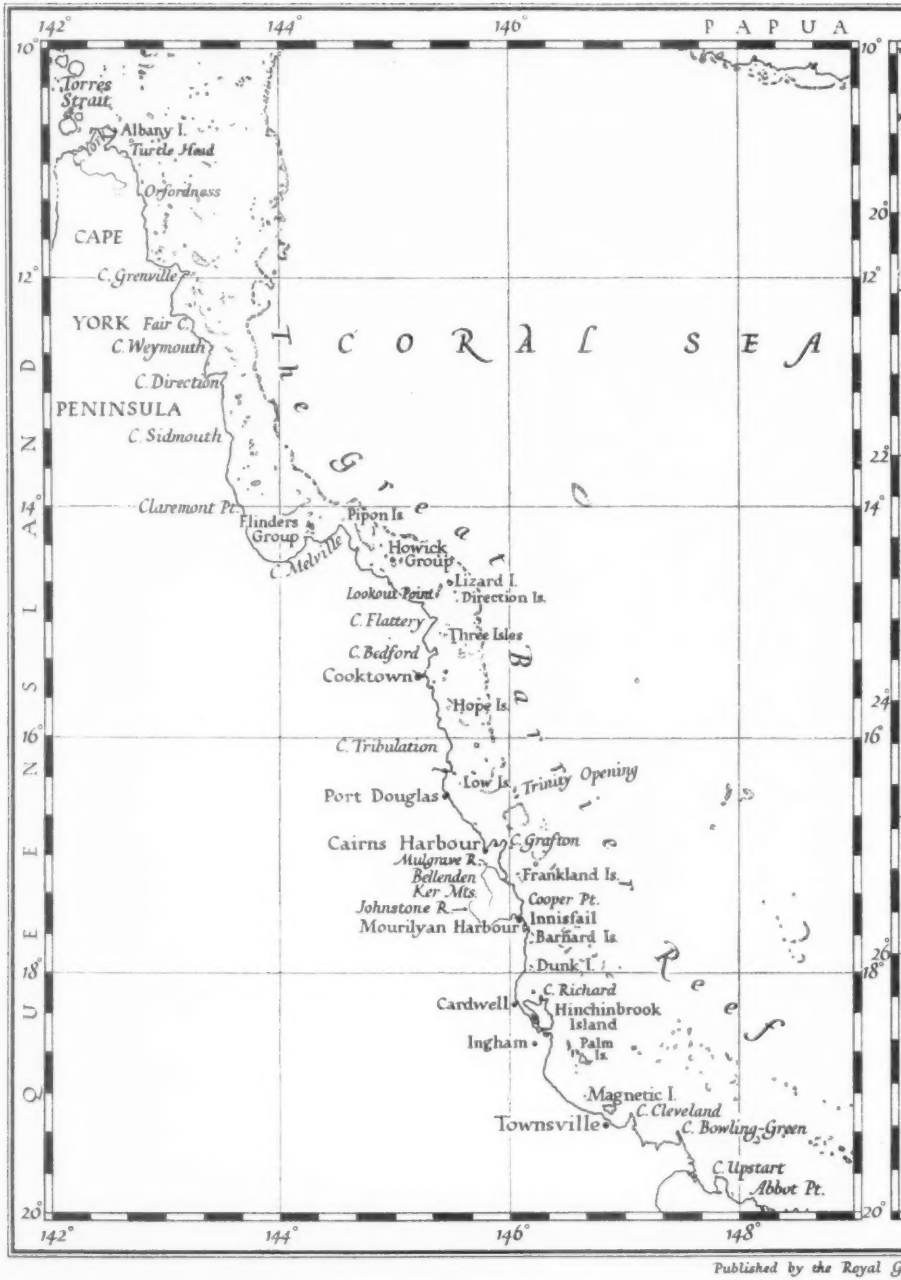

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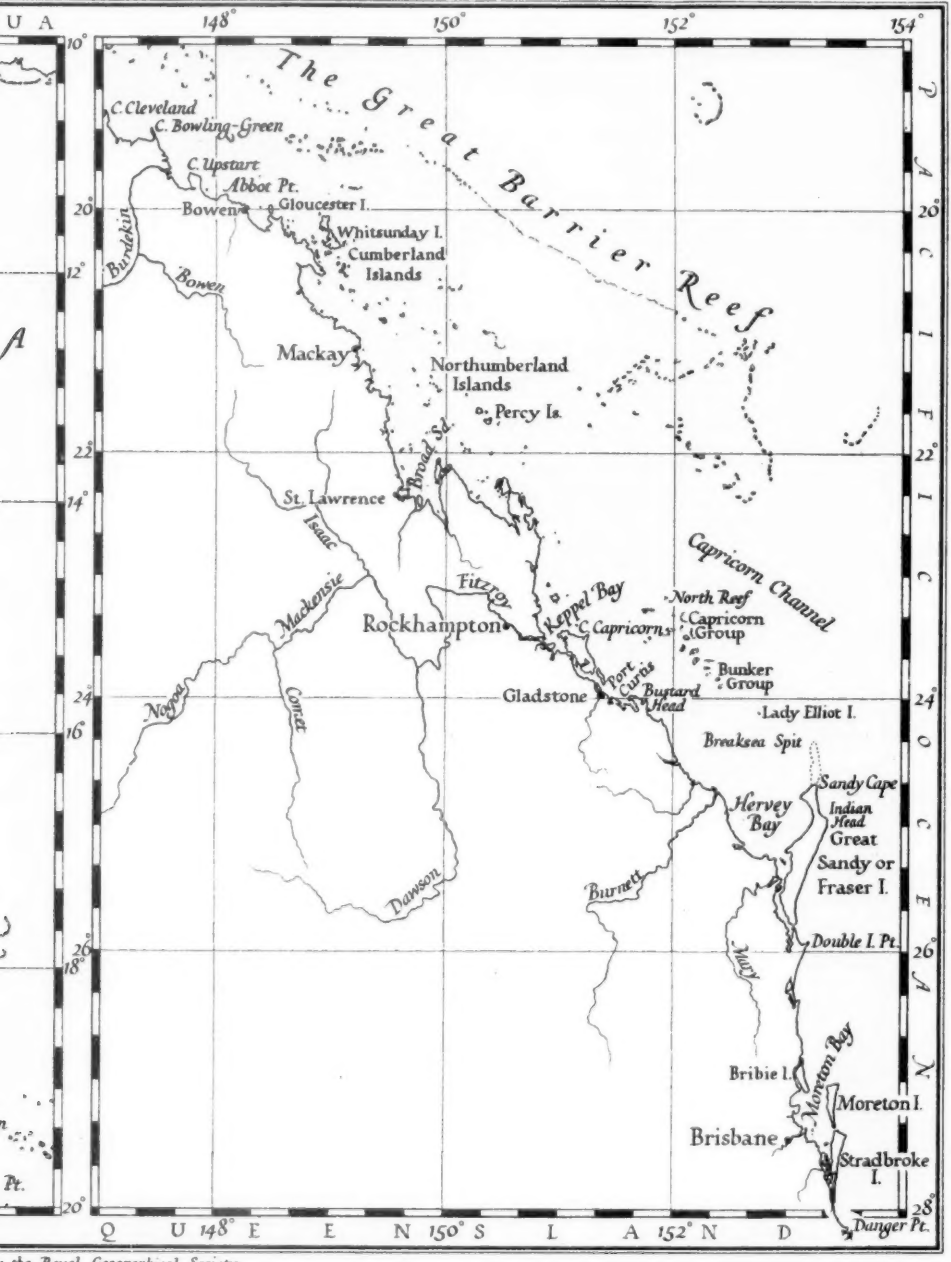

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